USES AND NUTRITIONAL VALUE OF INDIGENOUS VEGETABLES CONSUMED AS TRADITIONAL FOODS IN LESOTHO

By

Monica 'Maleabua Lephole

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Supervisor: M.S. Steyn
Co-Supervisor: Prof. G. Osthoff

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Dedication

"This work is dedicated to my mother Mamosiuoa Cornelia Lephole and my father Molai Makalo Lephole for their unconditional love, inspiration, encouragement and finanaical support throughout the entire study".

ACKNOWLEDGEMENTS

Praise be to God, who gave me life and strength to go through this work. I thank him especially for a wonderful family he gave me, which has been my source of inspiration throughout this study. I owe a debt of gratitude to many individuals for the successful completion of this work. I am indebted to the following people:

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Dr. M. Fair for his assistance in the statistical analysis and Kate Smith for coding and entering data into computer for statistical analysis;

Mr. W.J. Combrinck, Department of Animal Science, for his dedicated assistance during the laboratory analyses of vegetables;

Dr. P.J. DuPreez, Department of Plant Science, for his valuable assistance in the identification of plant species;

Dr. T. Jonathan, University of Lesotho, for her interest and encouragement towards the completion of this study, she has been my source of inspiration;

Mrs. A. Van der Westhuizen for her highly valued computer skills;

and finally, to Lesotho government, National Manpower Development Secretariat, for their financial assistance throughout my studies.

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CHAPTER 1

LITERATURE REVIEW

1.1 Introduction

Leafy vegetables hold an important place in well balanced diets. The idea of a well-balanced diet changed in recent years and lesser red meat and more vegetables and fruits are advised (Osler *et al*, 2001; Ames and Gold, 1996 and Kris-Etherton *et al*., 1988). In Africa, most vegetables are used as a relish (seshabo), which accompanies the starchy staple food. Indigenous vegetables play an important role in income generation and subsistence. Recent surveys carried out by the Natural Resources Institute in Cameroon and Uganda provided evidence that indigenous vegetables offer a significant opportunity for the poorest people to earn a living, as producers and/or traders, without requiring large capital investment (Schippers, 2000).

Traditional vegetables have been overlooked for such a long period of time, both by scientific and development communities. Despite their importance, traditional vegetables are being displaced in many areas, partly because of their neglect by the scientific community relative to some recently introduced species, on which there is much more scientific information, and improved varieties, which are more easily available. Not enough of indigenous plants are being moved into the specialised microenvironments of urban and peri-urban agriculture (Van den Heever, 1997). Indigenous leafy vegetables bear a potential to provide a valuable source of nutrition in areas with hot and dry climates. These vegetables could be particularly valuable in areas with a low or irregular rainfall, as they can produce a valuable yield under these conditions, whereas most of the exotic leafy vegetables require large amounts of water for successful production (Van den Heever, 1997). Most of the rural population cannot afford to purchase exotic vegetables due to the irregular income that they earn, thus this calls for more research and development of indigenous leafy vegetables. Indigenous leaves are popular and nutritious, having protein content of up to 36%, vitamin content depending on the age of the plant, cultivar of the plant and parts of a plant (Kruger *et al*., 1998; Madisa and Tshamekang, 1997). In their study titled “Conservation and utilization of indigenous vegetables in Botswana”, Madisa and Tshmekang (1997) further state that these vegetables complement the low calcium, magnesium and iron contents of maize, and the staple. Little knowledge available on indigenous leafy vegetables poses a challenge to scientific and development communities to divert their efforts and resources into thorough research on the role played by these vegetables in agriculture and food security.

1.2 Vegetables and their Nutritional Aspects

As a group the leafy vegetables are relatively low in dry matter and therefore energy. The leaves contain protein, sugars and cell-wall material, although on a weight basis the levels are relatively low (Whitney *et al*, 2001). The vegetables are usually consumed in large portion sizes and do make significant contributions as a whole to food intake. Their major importance lies in the contribution of vitamins as they contain carotenoids, folates and vitamin C. Potassium and magnesium are present at significant levels, and the vegetables contain a range of trace elements absorbed from the soil (Whitney *et al*, 2001). Many of the leafy vegetables are cooked before consumption, and cooking in water can lead to leaching and thermal losses of vitamin C, especially if vegetables are left standing when cooked prior to consumption (Whitney *et al*, 2001).

Vegetables provide fibre, minerals, vitamins, especially A, B, C, E and K, and some protein. They also provide other substances such as bioflavonoids and enzymes, which contribute to the healthy functioning of the body (Peters, 1999). It is best to eat vegetables in season and locally grown. Eating vegetables in season ensures that they are fresh. Some nutrients begin to dissipate as soon as the vegetable is picked. This is why frozen vegetables can be more nutritious than fresh ones. In their diversity of species, forms and texture, vegetables can supplement the diet with nutrients in a way that cannot be achieved with any other major energy-providing food. Green vegetables have a high content of water and an abundance of cellulose. (Allemann *et al*., 1995). Prasad *et al.*, (1993) stated that the cellulose is in a form, which although not digested, serves as a useful purpose in the intestines as roughage, thus promoting normal elimination of waste products. Due to their high water content, leafy vegetables are low in energy values.

Vegetables are the sole source of vitamin C in the diet of many people (Wills *et al*, 1998). Improved nutritional value should be the aim of anyone connected with any aspect of the fruit and vegetable industry, as it is a means of upgrading the health of the community without changing their food habits.

In the recent years, scientists have further reinforced the link between a diet containing high amounts of vegetables and good health. The American Institute for Cancer estimates that as many as 40% of all cancers in men, and 60% of those in women, are linked to diet, while other authorities suggest an overall figure of 35% (Lyons, 1998). Several studies have confirmed that populations with diets that are rich in vegetables and fruits run a lower risk of cancer. Dark green leafy vegetables such as kale and turnip greens contain compounds that may stop the conversion of certain lesions to cancerous cells in oestrogen-sensitive tissues and suppress tumour growth (Rawe, 2003). The general nutritional value of vegetables is as discussed below.

1.2.1 Carbohydrates

Carbohydrates are widely available, easily grown in grains, legumes, other vegetables, and fruits. In some countries (especially developing countries) carbohydrate rich foods make up almost the entire diet of the people. Carbohydrates are relatively low in cost as compared with many other food items and they may be easily stored. They can be kept in storage for relatively long periods without spoilage (Williams, 1995). The modern view, however, is that they are an essential part of a balanced diet and that humans should be eating more of them. The general dietary aim is that an increase in carbohydrates should be matched by a decrease in the amount of fat consumed, in order to help reduce the risk of coronary heart disease. There are three main forms of carbohydrates; starch, sugars and fibre (Whitney *et al*., 2001).

1.2.1.1 Starch

All starchy foods are derived from plants. Starch is the most important dietary carbohydrate worldwide (Williams, 1995). Just as the human body stores glucose as glycogen, plant cells store glucose as starches (Whitney and Rolfes, 2002). Starch, by far the most significant polysaccharide in the diet, is found in grains, in legumes and other vegetables and in minute amounts in some fruits (Williams, 1995). The cooking of starch not only improves its flavour but also softens and ruptures the starch cells, making digestion easier. Carbohydrates are converted by the body into glucose and glycogen (the animal equivalent of starch in plants). During exercise, our muscles are fuelled by glucose in the blood and by glycogen, stored in the liver and in the muscles themselves. Glucose and glycogen are inter-convertible; if the body has enough glucose, carbohydrates will be converted into glycogen, and if there is a shortage, glycogen will be turned into glucose. The digestion of carbohydrates helps to maintain the balance between the level of glucose in the blood and stores of glycogen (Williams, 1995).

1.2.1.2 Sugars

The dietary carbohydrate family includes the simple carbohydrates (the sugars). The sugars most important in nutrition are the 6 carbon monosaccharides known as hexane. The chemical difference accounts for the difference in sweetness of the monosaccharides. These are:

i. Glucose

This is commonly known as blood sugar, glucose gives an essential energy source for all the body’s activities. Its significance to human nutrition is tremendous. The body supply comes mainly from the digestion of starch (Williams, 1995).

ii. Fructose

Fructose occurs naturally in fruits and honey; other sources include products such as soft drinks, ready-to-eat-cereal, and desserts that have been sweetened with high fructose corn syrup (HFCS) (Whitney and Rolfes, 2002). The amount of fructose in fruits depends on the degree of ripeness (Williams, 1995).

iii. Galactose

Galactose comes mainly from the digestion of milk sugar, lactose (Williams, 1995). Galactose is occurring free in nature and it binds with glucose to give the sugar in milk (Whitney and Rolfes, 2002).

1.2.1.3 Fibre

A healthy diet will include fibre, a natural part of plant foods. It comes from the cell walls of the plants – the older the plant, the tougher the fibre. The more food is cooked, the more the fibre content is reduced (Peters, 1999).

Although fibre has almost no nutritional value in itself, it is vital for digestion. The more fibre is eaten, the more water is absorbed by the digestive tract. This increases the bulk of the faeces, which can then pass through the body more easily and comfortably. High fibre intake also aids blood sugar control and lowers the cholesterol count by helping the body excrete the substance. As a bonus, fibre is filling, which encourages the health by causing a consciousness to resist sugary and fatty refined foods. Diets deficient in fibre can leave people susceptible to diabetes, heart disease and intestinal disorders such as bowel cancer, diverticular disease, gallstones and constipation. There are two types of fibre: soluble and insoluble. Many foods, particularly whole grains, contain both soluble and insoluble fibre. Soluble fibre is found in most fruits and vegetables, pulses and oats. These foods lower the absorption of carbohydrates and slowly release sugar into the bloodstream. Insoluble fibre is found in nuts, bran, rice and fruit peel. It passes through the intestine unchanged, but is a vital link in the digestive process (Peters, 1999). Vegetables are therefore an essential source of soluble and insoluble fibre.

1.2.2 Proteins

In a never-ending ‘nitrogen cycle’, plants use the nitrogen to form their own amino acids and proteins. Animals eat the plants and use the amino acids for their tissues. Humans eat animals and plants for their amino acids and rearrange the nitrogen to make the pattern of amino acids required (Mahan and Escott-Stump, 2000). Vegetable protein is less well digested than animal protein, partly because it is encased in fibre-carbohydrate cell walls and is less available. Some plants also contain enzymes that interfere with protein digestion (Mahan and Escott-Stump, 2000). These enzymes must be heat inactivated before consumption. For example, soybeans contain trypsin inhibitors that inactivate trypsin, the major protein digesting enzymes in the intestine (Snyder and Kwon, 1987). Madisa and Tshamekang (1997), indicate that indigenous vegetable leaves are nutritious, having a protein content of up to 36%.

1.2.3 Fat

Lipid content of vegetables is small but significant in terms of storage and quality, due to undesirable flavour changes resulting from rancidity (Eskin *et al*., 1971). Eskin *et al*., further states that studies that were undertaken on changes in the fatty acid composition in potatoes showed a marked decrease in linoleic acid content and an increase in palmitic acid and linolenic acid.

1.2.4 Minerals

The levels of some minerals found in foods often depend on the amounts present in the soil where plants were grown or animal grazed. The full range of minerals present in the soil will be present in the plant because plants also absorb minerals other than those, which are necessary for growth. However, there is no general correlation between the mineral content of the soil and the plant (Kruger *et al*., 1998). The mineral composition appears to be broadly characteristic of the species and cultivar, although considerable differences can occur between different fruit from one plant and between different parts of the same plant (Salunkhe *et al*., 1991).

Minerals perform a multitude of functions throughout the body. Depending on the amounts present in food and the nutritional need, minerals are classified as major minerals and trace minerals (Whitney *et al.*, 2001). The distinction between the major and the trace mineral does not mean that one group is more important than the other. The deficiency of the few micrograms of zinc needed daily is just as serious as a deficiency of the several hundred milligrams of calcium. Although the nutritional advantages of eating a balanced diet are well known, deficiencies in certain minerals, such as zinc, calcium or iron is still relatively common. Scientists have identified 16 minerals as being essential, if the body is to function properly. For a mineral to be considered essential it must perform at least one function vital to life, growth and reproduction.

The body can maintain its own mineral balance over short periods. If intake of minerals is low, it draws from stores laid down in the muscles, the liver and even the bones. If a mineral intake is too high, any excess is usually excreted so that there is little danger of the body being harmed (Whitney *et al.*, 2001). According to Peters (1999) the ideal amount of a particular vitamin or mineral for an individual depends on the physical and mental state, age and gender. Many people are often short of vital minerals, especially zinc, iron and calcium. Only seven minerals will be discussed in this chapter, i.e. those that are the most important in nutrition. The same minerals will also be analysed for their content in the vegetables understudy (chapter4, section 4.4.2).

1.2.4.1 Iron

Iron deficiency anaemia is one of the most prevalent forms of malnutrition in children. Iron deficiency can affect learning ability, intellectual performance, stamina, and mood (Grosvenor and Smolin, 2002). Every living cell, both plant and animal contains iron. The iron helps carry and hold oxygen and then release it. Iron has other several vital functions in the body; as a carrier of oxygen to the tissues from the lungs, as a transport medium for electrons within cells. If there is surplus of iron, special storage proteins in the liver, bone marrow, and other organs store it (Whitney *et al*, 2001). The recommended daily intake for adult men is 10 mg and for adult women is 15 mg (Whitney *et al.*, 2001).

1.2.4.2 Zinc

Zinc is a versatile trace mineral required as a cofactor by more than hundred enzymes (Whitney *et al*, 2001). Zinc works with the enzymes that make genetic material, manufacture heme, digest food, metabolise carbohydrates, protein, and fat, liberate vitamin A from storage in the liver, and dispose of damaging free radicals. Zinc is needed to produce the active form of vitamin A in visual pigments and is essential to wound healing, taste perception, the making of sperm, and foetal development

(Whitney *et al*, 2001). When zinc deficiency occurs, it impairs all these and other functions. Zinc recommendation for men is 15 mg per day and for women is 12 mg. Zinc intake correlates well with protein intake.

1.2.4.3 Manganese

The human body contains a tiny 20 mg of manganese, mostly in the bones and glands (Whitney *et al*, 2001). Manganese requirements are low and plant foods such as nuts, whole grains, and green leafy vegetables contain significant amounts of this trace mineral. Deficiencies are therefore unlikely. Estimated safe and adequate dietary intake for manganese is 2.5-5.0 mg/day (Mahan and Escott-Stump, 2000).

1.2.4.4 Sodium

Sodium is the principal electrolyte in the extra cellular-fluid and the primary regulator of the extra-cellular fluid volume (Whitney *et al*, 2001). Sodium is the most noted mineral that influences the body's fluid balance. When the blood concentration of sodium rises, such as when a person eats salted foods, thirst prompts the person to drink water and the body sets in motion mechanisms to attain the appropriate sodium-to-water ratio. Sodium also helps maintain the acid-base balance and is essential to muscle contraction and nerve transmission (Whitney *et al*, 2001).

1.2.4.5 Calcium

A range of foods from milk and cheese to sardines (eaten with their bones) and dark green leafy vegetables contain calcium. Calcium is the most abundant mineral in the body (Whitney *et al*, 2001). Calcium is a vital component of bones and teeth, which contains 99% of the body calcium. The other 1% plays an equally important role in the body both in cell structure and function, as well as in the blood, where it aids clotting. Because of the body's natural regulatory systems, excessive calcium in the blood occurs rarely and only as a result of disease or through overuse of vitamin D supplements. If, the body needs more calcium, it withdraws it from the bones (Whitney *et al*, 2001).

1.2.4.6 Potassium

Potassium also plays a major role in maintaining fluid and electrolyte balance and cell integrity. Potassium is also critical to keep the heartbeat steady. The sudden deaths that occur in severe diarrhoea and in children with kwashiorkor are likely due to heart failure caused by potassium loss (Whitney *et al*, 2001). Potassium depletion is always associated with abnormal losses of potassium from the body, and has not been reliably reported from reduced potassium intake alone (Nelson, 2000). Potassium is abundant in all living cells, both plants and animals and the richest sources of potassium are foods of all kinds especially fruits and vegetables (Nelson, 2000).

1.2.4.7 Magnesium

Magnesium is critical to the functioning of hundreds of enzymes. Magnesium acts in all the cells of the soft tissues, where it forms part of the protein-making machinery and is necessary for the release of energy. Magnesium ranks the second in content to potassium as an intracellular cation (Whitney *et al*, 2001). The adult human body contains approximately 20 to 28 g, of which approximately 60% is found in bone, 26% in muscle, and the remainder in soft tissues and body fluids (Mahan and Escott-Stump, 2000). Magnesium is abundant in many foods and the ordinary diet should provide adequate amounts, if the right foods are selected for consumption (Mahan and Escott-Stump, 2000).

1.2.5 Vitamins

Grosvenor and Smolin (2002) indicate that the low intakes of vitamins A, B and E are most likely due to low intakes of fruits and vegetables. Skilful sampling is important in vitamin analysis because of the great variability of the materials, which are assayed. Vegetables of different varieties from one garden differ in vitamin content, and vegetables of the same variety differ if grown in several geographical locations. Spinach leaves may differ from each other, depending upon the state of maturity or whether the sample is taken from the sunny side or has been shaded. In this study, the content of two vitamins in vegetables will be investigated and analysed (Chapter 3 and 4), and these are vitamin C and β-carotene (vitamin A precursor) because generally fruits and vegetables are good sources thereof. In some vegetables, mature dark green leaves contain more vitamin C and beta-carotene than do younger leaves of the same plant (Kruger *et al*., 1998).

1.2.5.1 Vitamin C

The major sources of vitamin C are vegetables and fruits, especially spinach, tomatoes, potatoes, broccoli, strawberries, oranges and other citrus fruits. There is no vitamin C in animal material, therefore green plants are important. (Garrows and James, 2000). Grosvenor and Smolin state that the low intake of vitamins A, C and E are most likely due to low intakes of fruits and vegetables.

1.2.5.2 β-carotene (Vitamin A precursor)

Vitamin A is mainly found in the animal kingdom, and a proportion of the daily requirements come from animal sources. Vitamin A precursors (provitamins) are widely distributed in the vegetable kingdom. These are the carotenoids, which have certain structural characteristics and form part of the yellow and orange pigment of most fruits and vegetables (Marks, 1968). Zanutto *et al*., (2002) reported that green leafy vegetables are traditionally considered to be good sources of vitamin A since they contain carotenoids, especially β-carotene, and that it shows good bioavailability from these sources. This discovery indicates that green leafy vegetables make up a larger and important portion of the human diet for a better health.

1.2.6 Moisture content

Water occurs in foods essentially in two forms; as bound water molecules chemically or hydrogen bonded to ionic and polar groups, and free water which is not physically linked to the food matrix and which is freezable and easily lost by evaporation or drying (Nelson, 2000). In plant foods, storage time and conditions are major sources of variation in water content. Changes in water content are associated with changes in nutrient density and therefore affect all the other nutrients (Greenfield and Southgate, 1992).

1.3 Indigenous Vegetables and their Nutritional Value

Indigenous vegetables are important commodities for poor households because their prices are relatively affordable when compared to other food items. Shava (1999) stated that wild food plants have provided food security to African communities even during times of drought, and they have been proven to be excellent nutritionally.

Mnzava (1997) and Allemann *et al* (1995) also maintain that wild vegetables can help to address problems of malnutrition, especially during periods of drought, since exotic vegetable species, which are normally cultivated, cannot thrive under the harsh climatic conditions, which are encountered in Southern Africa. Amaranth and Dandelion will be reviewed in this chapter as the models of what has been researched. Only these two indigenous vegetables will be discussed because they have been extensively researched, and different authors (Wildman, 2002; Van Wyk *et al*., 2000; Grieve, 1997; Saunders and Becker, 1984) have documented information on their use and nutritional importance.

1.3.1 Amaranth (*Amaranthus hybridus)*

Amaranth was first analysed by Boutin, 1983 (Saunders and Becker, 1984). The plant was becoming commercially important because housewives of that time were using it to clean their cooking utensils, attributing its ability to "cut grease" to plant acid (Saunders and Becker, 1984).

Amaranths, also called Chinese spinach, are bushy green leafy coloured plants, some of which have leaves that can be eaten and taste similar to spinach, while others produce seeds that can be used as grain. The plant is a relative of the pigweed, which is a wild plant. Approximately sixty species of amaranth exist in the world. Certain varieties are considered vegetables and are grown specifically for their leaves, while others are grown only for their seeds. One variety, named Joseph's coat, is used mainly for decorative purposes, as a bedding plant. Due to its highly recorded nutritional value, amaranth is being grown in the United States and used as a food additive (Saunders and Becker, 1984).

The U.S. has been the leading commercial producer of grain amaranth in recent years. Since U.S. farmers started growing the crop in the early 1980s, production is less than 2 000 ha annually (Myers, 1996). Myers (1996) evaluated the evidence on amaranth's domestication, and concluded that amaranth came into use as a grain at-least 6 000 years ago in Central America. Although the production of amaranth in Latin America diminished dramatically subsequent to Spanish rule, the positive attributes of the crop led to its adoption in other areas of the world. During the 20th century it was grown in China, India, Africa and Europe, as well as North and South America (Myers, 1996; Stallknecht and Schulz-Schaeffer, 1993).

In some African countries amaranth is being extensively studied for its commercial properties. Amaranth growing in Lesotho, just like other wild plants, has not received any recognition in terms of research although it is mainly utilised as edible vegetable for both human and animal consumption. So far only the young tender leaves are used for consumption.

The National Academy of Sciences lists amaranth (vegetable and grain) as one of 23 food plants that could be used to improve nutrition and the quality of life for people in developing countries (Sealy *et al*, 1990). Sealy *et al* (1990), further states that the leaves of amaranths are nutritionally significant sources of proteins, carbohydrates, several vitamins and minerals, and dietary fibre. Amaranth has also been judged as a very acceptable vegetable by organoleptic judging panels (Teutonico and Knorr, 1985).

1.3.1.1 Morphology

The amaranth plant is identified by its broad leaves and produces clover-like flowers. These flowers contain seeds that are used in a variety of ways, including commercially produced cereals, similar to puffed rice, pastas and baked goods. Amaranth grows better in warm weather with conditions that include much light. In conducive environment, where the sunlight, rain and soil conditions are represented according to standards, amaranth can grow to heights of up to 1.5 m and amaranth is ready for harvesting 5-6 weeks after their seeds have been sown. Due to many varieties of amaranth that exist to date, it is important to know whether the leaves and seeds are edible when purchasing an amaranth plant or seeds for planting (Saunders and Myers, 1984)

Amaranth grains

Amaranth grains (Figure 1.1) are lenticular in shape and they are generally about 1-1.5 mm in diameter, with 1000 seeds weighing approximately 0.6-1.0g. Selections have been made over the years for pale-coloured grain types, but not for grain size. Seed colour ranges from off-white, through beige, light browns, and black. Pigments are located in the outer layer of the seed coat. An amaranth plant typically produces 40,000-60,000 seeds (Saunders and Becker, 1984).

Figure 1.1 Amaranth grain structure

Amaranth leaves

Data describing the composition of vegetative growth of amaranth plants vary significantly, mainly due to factors such as climate, plant nutrition, horticultural practices, cultivar, and leaf age at harvest. Amaranth varies greatly in colour of the foliage, the shape of the leaves and the height of the plant (Saunders and Becker, 1984). A typical example is shown in Figure 1.2.

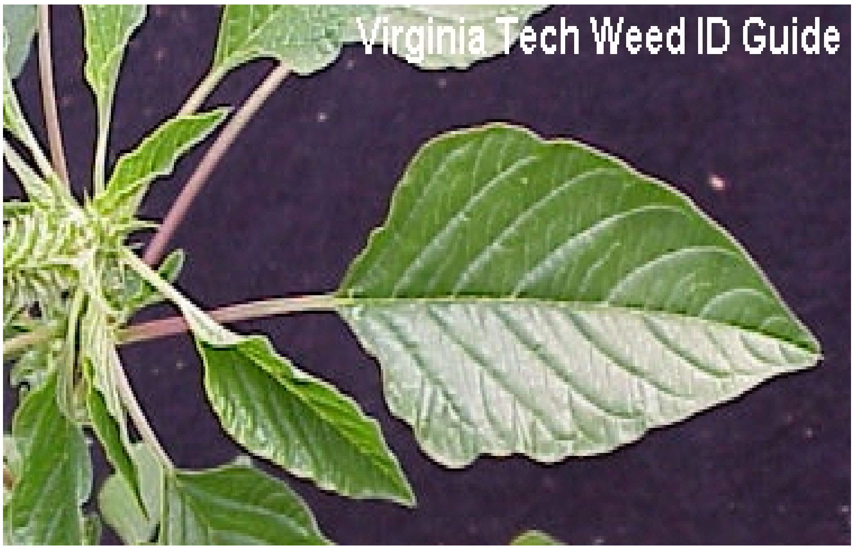

Figure 1.2 Amaranth leaf structure

1.3.1.2 Nutritional significance

According to Stallknecht and Schulz-Schaeffer (1993), amaranths have been divided in principally four groups: cultivated, wild and weedy, racial (based on geographic and morphological patterns), and landrace (populations from specific locations). The nutritional composition of both grain and vegetable amaranth has been extensively studied, however, vegetable amaranth has received less research efforts. Grain amaranths have good potential as food or feed crops due to their rapid growth pattern typical of the C4 photosynthetic pathway and their ability to grow in areas where temperate crops do not thrive (Becker *et al*., 1981). The grain was noted to be nourishing in infants and to provide energy and strength to soldiers on extended trips (Becker *et al*., 1981). Amaranth grain is still studied more due to its nutritional potential and use in industrial and food products. Stallknecht and Schulz-Schaeffer (1993) indicated that amaranth grain is considered to have a unique composition of protein, carbohydrates, and lipids. Grain amaranth has a higher protein content (12-

18%) than other cereal grains, has a significantly higher lysine content and contains about 63% waxy starch (Stallknecht and Schulz-Schaeffer, 1993; Becker *et al*, 1981). The protein value of amaranth grain is highlighted when amaranth flour is mixed with other cereal grain flour. When amaranth flour is mixed 30:70 with rice, maize, or wheat flour, the protein quality (based on casein) rises from 72 to 90, 58 to 81, and 32 to 52 respectively (Stallknecht and Shulz-Scheaffer, 1993). Table 1.1 shows the proximate and mineral composition of seven Amaranth seed samples.

Table 1.1 Proximate and mineral composition of grain Amaranth species (Becker *et al*, 1981).

Analysis	Samples						
	P.I.337611 No N, H_2O	P.I.337611 75 lb N	P.I.337611 150 Ib N	A. *cru.x* A. *hypo*	P.I.274277 75 Ib N	Crop x weed Hybrid	A.*edulis*
% Moisture	9.82	9.44	9.87	9.60	9.73	10.72	9.55
% Protein	17.37	17.26	17.67	16.09	15.74	15.33	15.80
%Fat	7.71	7.48	7.60	8.03	6.15	5.56	5.56
%Fibre	3.36	4.39	3.46	4.25	4.15	5.84	3.23
%Ash	3.77	3.32	3.68	3.04	3.58	3.32	3.18
Minerals (ppm)							
Sodium	450	220	310	160	270	480	370
Potassium	5200	3200	4200	3800	4600	4100	5800
Calcium	1600	2150	1300	1700	1900	2850	1700
Magnesium	3320	3080	2890	2300	2740	3360	2890
Iron	90.8	73.2	105	106	104	72.2	84.2
Zinc	39.5	39.6	37.4	36.2	38.8	37.6	40.0
Copper	8.4	7.9	7.9	8.2	7.9	13.2	8.0
Manganese	23.6	22.6	19.2	23.2	22.8	15.9	22.2

Data describing the composition of vegetative growth vary significantly due to factors such as climate, plant nutrition, horticultural practices, cultivar, and leaf age at harvest (Saunders and Becker, 1984). Current interest in amaranth as a food source for humans and animals has been stimulated by activities/collection and testing by The National Academy of Sciences and Rodale Organic Gardening and Farming Research Centre, Kutztown, PA.

Amaranth leaves have a potential as a protein supplement, containing 17.4 to 38.3% dry matter as crude protein, with 5% lysine (Teutonico and Knorr, 1985). Vitamins C and A are present at nutritionally significant levels, averaging 420 ppm and 250 ppm respectively. Minerals such as potassium, iron, magnesium and calcium are also present in significant amounts. The presence of large amounts of oxalates, ranging from 0.2 to 11.4% (dry matter) may limit availability of these nutrients (Becker *et al*, 1981). The proximate, mineral and vitamin content of amaranth greens are compared with those of spinach, vinespinach, collards, and chard in Table 1.2.

Table 1.2 - Nutrient content of selected raw vegetable leaves compared to amaranth (Saunders and Becker, 1984).

Component	Amaranth	Spinach	Vinespinach (Basella)	Collards Leaves Without Stem	Chard
Dry mater (g)	13.1	9.3	6.9	14.7	8.9
Energy, cal (g)	39	26	19	45	25
Protein (g)	3.5	3.2	1.8	4.8	2.4
Fat	0.5	0.3	0.3	0.8	0.3
Carbohydrates					
Total (g)	6.5	4.3	3.4	7.5	4.6
Fibre (g)	1.3	0.6	0.7	1.2	0.8
Ash (g)	2.6	1.5	1.4	1.6	1.6
Calcium (mg)	267	93	109	250	88
Phosphorus (mg)	67	51	52	82	39
Iron (mg)	3.9	3.1	1.3	1.5	3.2
Sodium (mg)	-	71	-	-	14.7
Potassium (mg)	411	470	-	450	550
Vitamin A, IU	6,100	8,100	8,000	9,300	6,500
Thaimin (mg)	0.08	0.10	0.05	0.16	0.06
Riboflavin (mg)	0.16	0.20	-	0.31	0.17
Niacin (mg)	1.4	0.6	0.5	1.7	0.5
Vitamin C (mg)	80	51	102	152	32

[a]Per 100g of edible portion.

1.3.2 Dandelion (*Taraxacum officinale*)

Dandelions are the best-known plants in the world but one of the least understood (Tilford, 1993). Tilford further indicates that dandelion is one of the most complete plant foods on earth, providing many valuable nutrients in a form that is easy for the body to process.

Dandelion is a common plant worldwide and is one of the lettuce family members (Figure 1.3) (Grieve, 1995). The dandelion, though not naturally occurring in the Southern Hemisphere, is found in all parts of the northern temperate zone, in pastures, meadows and on waste ground, and is as plentiful that farmers everywhere find it a troublesome weed (Grieve, 1995). Dandelion is grown commercially in the United States and Europe. It has been used in herbal medicine to treat poor digestion, water retention, and diseases of the liver including hepatitis. It has been assumed that the bitter substances of dandelion form the basis for its therapeutic effects. Several constituents have been identified. These include sesquiterpene lactones, taraxacoside, triterpenes, phytosterols, phenolic acids, flavonoids, vitamins and minerals (Simandi *et al.*, 2002).

1.3.2.1 Morphology

Figure 1.3 Dandelion plant

The long jagged leaves of dandelions rise directly from the thick taproot, and is dark brown, almost black on the outside though white and milky within. The leaves radiate from the taproot to form a rosette lying close upon the ground, each leaf being grooved and constructed so that all the rain falling on it is conducted straight to the centre of the rosette and thus well watered. The maximum amount of water is in this manner directed towards the proper region for utilisation by the root, which but for this arrangement would not obtain sufficient moisture, the leaves being spread too close to the ground for the water to penetrate (Grieve, 1995). Roots, leaves and flowers of dandelion have been used for various products.

Dandelion Leaves

The dandelion is a perennial, herbaceous plant with long, lance-shaped leaves (Figure 1.4). They're so deeply toothed, they gave the plant its name in French: Dent-de-lion means lion's tooth in French. The leaves are 8.89 cm long, and 1.27 – 6.35 cm wide, always growing in a basal rosette. The rosette's immature, tightly wrapped leaf bases just above the top of the root form a tight "crown" (Wildman, 2002; Grieve, 1995). There are many varieties of dandelion leaves; some are deeply cut into segments, in others the segments or lobes form a much less conspicuous feature, and are sometimes almost entire (Grieve, 1995). The thick, brittle, beige, branching taproot grows up to 25.4cm long. All parts of this plant exude a white milky sap when broken (Wildman, 2002). As the leaves mature, they will exude a white sap when torn, just like all members of lettuce family (Grieve, 1995).

Figure 1.4 Dandelion leave

Dandelion roots

Dandelion roots (Fig ure 1.5) have long been largely used on the continent, and the plant is cultivated largely in India as a remedy for liver complaints. The root is perennial and tapering, simple or more or less branched, attaining in a good soil a length of a 30 cm or more and 1.5 cm to and 2.5 cm in diameter. Old roots divide at the crown into several heads. The root is fleshy and brittle, externally of dark brown, internally of bitter, but disagreeable taste (Grieve, 1995).

Figure 1.5 Dandelion roots

Dandelion flower

Dandelion flowers are yellow and gold (Figure 1.6). The green sepals at the flower's base are bitter. (Wildman, 2002).

Figure 1.6 Dandelion flower

1.3.2.2 Nutritional significance

The plant is rich in vitamin A, C and D, in iron, calcium, magnesium and potassium. It also gets its marks as a source of fibre and vegetable protein (Anderson, 2003). Table 1.3 illustrates the nutritional facts about dandelion as is presented by USDA.

Table 1.3 Dandelion nutritional facts per 100g of fresh sample (USDA, 1999).

Nutrients	Units	Dandelion raw
Water	g	85.6
Energy	kcal	45
Protein	g	2.7
Total lipid (fat)	g	0.7
Carbohydrate	g	9.2
Fiber, total dietary	g	3.5
Minerals		
Calcium	mg	187
Iron	mg	3.1
Magnesium	mg	36
Phosphorus	mg	66
Potassium	mg	397
Sodium	mg	76
Zinc	mg	0.41
Copper	mg	0.171
Manganese	mg	0.342
Selenium	mg	0.5
Vitamins	mg	35
Vitamin C		
B-1 (thiamin)	mg	0.19
B-2 (riboflavin)	mg	0.26
B-3 (niacin)	mg	0.806
B-5 (pantothenic acid)	mg	0.804
B-6 (pyridoxine)	mg	0.251
Folate	mcg	27.2
B-12	mcg	0
Vitamin A	I.U	14000
Vitamin A	Mcg RE	1400
Vitamin E	Mcg ATE	2.5
Lipids		
Fatty acids, saturated	g	0.17
Fatty acids, monounsaturated	g	0.014
Fatty acids, polyunsaturated	g	0.306
Linoleic acid (18:2)	g	0.261
Alpha-linolenic acid (18:3)	g	0.044
Cholestrol	mg	0

1.4 Uses of Indigenous Vegetables

Indigenous vegetables have the advantage of surviving the harsh climates, thus, being available in times of drought and hunger (Mnzava, 1997).

1.4.1 Amaranth (*Amaranthus hybridus*)

1.4.1.1 Amaranth agronomic status

According to Myers (1996) the current status of amaranth is as a crop, which has great potential, a variety of possible uses, and a decade-plus of research behind it. However, as with most alternative crops, cultivar improvements are needed, production and utilization research challenges also remain. Production research has been conducted in several states of the USA and most of them focused on practical questions such as seeding rates, planting dates, row widths, and fertilizer response. Insect and pest diseases of amaranth have also been evaluated (Myers, 1996).

Amaranth is a warm-season crop, which germinates when soil temperatures range from 18-24℃. The normal range of planting dates is May to early June in the USA (Shroyer *et al*., 1990). When planting early, amaranth will start flowering after it has accumulated enough growth heat units. It is further recommended that amaranth should be planted 1.27 cm deep, with the row width of 76.2 cm. The wide rows allow a row cultivar to be used for weed control. Wider rows also give higher yields (Myers, 2002).

Amaranth does not have a high nitrogen demand like corn, but yields are responsive to good nitrogen fertility (Myers, 2002). It is not easy to harvest amaranth, especially grain amaranth. When amaranth populations are low, the seed heads become extremely large and do not dry properly. Adequate plant population and a killing frost to dry down the plants to harvest are necessary for an effective harvest (Stallknecht and Schulz-Schaeffer, 1993). It has been indicated that grain combines can be used to harvest efficiently. Since amaranth grain must be 12% moisture or lower for storage, the producer must be prepared to dry the harvested seed prior to storage (Stallknecht and Schulz-Schaeffer, 1996). Cleaning the grain is important to get full value, since the crop is used for food purposes. Grain amaranth should be stored at about 10-12% moisture (Myers, 2002)

Cutting the plants above the second leaf from the ground, at a height of about 7.5cm, after they have attained a marketable size usually carries out harvest for vegetable use. Cutting is done at various lengths (15-23cm) in the first instance, and subsequently, branches are included. Alternatively, harvesting can be done by uprooting the whole plant at an early stage. The quality of the vegetables is affected by flowering. Plants that are flowering are not harvested but are left to seed (Mposi, 1999). Mposi (1999) further indicate that if the leaves are harvested, it is traditional in West Africa to soak the plant in water before transporting it to the market as this gives the leaves a fresh look. The leaves are arranged in bunches that are usually spread on a raffia tray in the market stalls or else hawked in the street. Since evaporation takes place rapidly, more water is sprinkled on the leaves at regular intervals.

1.4.1.2 Amaranth processing

Amaranth is one of the very few double-duty plants. Currently, flour processed from amaranth grain is being increasingly used in tortillas, breads, cookies, pasta, and marzipan, and has recently become available as an ingredient in a commercial breakfast cereal (Teutonico and Knorr, 1985). Amaranth has certain seed components with potentially high value uses. The anthocyanin (reddish) pigments in amaranth flours and vegetation appear to have great potential for competing with sugar beets as a source of natural, non-toxic red dyes (Myers, 2002).

The leaves can be used as a tasty vegetable, often preferred to spinach by some people (Mposi, 1999). Traditional recipes for the preparation of amaranth seeds and greens vary among cultures. Vegetable types (or port-herbs) are usually picked fresh, washed, and used as greens in salads or are blanched, steamed, boiled, stirfried, or baked to taste (Saunders and Becker, 1984). The cooked amaranth greens can be used as a side dish, in soups, or as an ingredient in baby food, casserole, lasagne, pasta, pie crusts, quiche, soufflé, etc. In Lesotho people collect amaranth greens mainly as a port-herb, which is cooked either alone or mixed with other wild vegetables to alter taste. The water for cooking is either discarded or served, depending on individual choices. In the food processing area, research and development work is needed on shelf life, the functionality of grain amaranth and amaranth protein concentrates, and the effects of processing on functionality and nutritional quality of amaranth leaves and seeds (Teutonico and Knorr, 1985). New products need to be created into the existing food industry so as to attract the market.

1.4.1.2.1 Food uses in America

Grain amaranth

Amaranth seeds have some desirable functional characteristics, having been processed in popped, flaked, extruded, and ground flour forms. Most of the amaranth in U.S. food products starts as ground flour that is blended with wheat or other flours to make cereals, crackers, cookies, bread or other baked products (Myers, 2002). In less developed countries in Central and South America, the grain is ground and used as a flour ingredient in such basic foods as pinole, tamales, and atole. The grain is also commonly popped by being heated over a low flame, and the popped amaranth can be consumed as is or used as an ingredient or confection (Saunders and Becker, 1985). Most commercial products use amaranth as a minor portion of the ingredients, even if the product is touted as an amaranth product, such as “amaranth” breakfast cereal, which may be only 10 to 20% amaranth (Myers, 2002). Myers (2002) further states that since the food uses are similar to such cereal grain grasses as wheat and oats, amaranth is sometimes called a “pseudocereal”.

Vegetable amaranth

Vegetable types (or potherbs) are usually picked fresh, washed and used as greens in salads or are blanched, steamed, boiled, stir-fried, sautéed, or baked to taste. The cooked amaranth greens can be used as a side dish, in soups, or as an ingredient in baby food, casserole, lasagne, pasta, pie crusts, soufflé, etc (Saunders and Becker, 1985).

1.4.1.2.2 Food uses in Mexico

Grain amaranth

A traditional use of amaranth in Mexico and other countries is to mix popped grain amaranth with a sweet, sticky foodstuff, such as molasses or honey, to make a type of snack bar cake (not unlike a granola bar or Rice Crispy bar). The whole seed is sometimes used in a type of porridge or as a condiment on other foods. The ground flour is used in a variety of baked breads (Myers, 2002; Early, 1990).

Vegetable amaranth

In both Mexico and Peru, wild amaranth leaves are gathered, boiled and fried (Myers, 2002).

1.4.1.2.3 Food uses in Southern Africa

In Southern Africa, amaranths are widely used as spinach. Basically 'moroho' is a term used for amaranth leaves. Commercial scale farming has become popular in recent years, and nowadays the leaves are also processed and canned (Van Wyk *et al*., 2000). Amaranth is clearly a crop with high potential, especially as a source of high quality food. The research done at the Roodeplaat Agricultural Research Centre has shown that small-scale farmers can easily grow amaranth and it can contribute significantly to a reduction in the incidence of malnutrition amongst young children (Van Wyk *et al*., 1997). No information on the processing of amaranth was found.

1.4.2 Dandelion *(Taraxacum officanale)*

1.4.2.1 Dandelion agronomic status

When dandelion is grown as a crop, large roots are preferred to insure that they are more easily dug, generally being ploughed up (Grieve, 1995). About 5kg of seed to the hectare should be allowed, sown in drills, 300mm apart. The crops should be kept clean by hoeing, and all flower-heads should be picked off as soon as they appear, as otherwise the grower's own land and that of his neighbours will be smothered with the weed when the seeds ripen (Grieve, 1995). Dandelions grow in rich, moist soil, with the broadest leaves and largest roots (Wildman, 2002). The yield should be 4 or 5 tons of fresh roots to the hectare in the second year. Under favourable conditions, yields at the rate of 1,100 to 1,700 kg of dry roots per hectare have been obtained from second-year plants cultivated.

1.4.2.2 Dandelion processing

Dandelions are known to impact positively upon an incredible range of processes. The yellow-flowered perennial is a storehouse of vitamins and every part – root, leaf, flower and sap – is useful to humans (Van den Heever, 1997). Dandelion has commonly been regarded as a weed and most research has focused on its eradication rather than its cultivation. Dandelion has both medicinal and culinary uses (Rangahau, 2002). Dandelion leaves are best collected in early spring, when they are the tastiest, before the flowers appear, and can be harvested (Wildman, 2002).

1.4.2.2.1 Food uses in New Zealand

Dandelion is an introduced and widespread weed in New Zealand that is often found growing in wasteland, lawns and fields. Roots, leaves and flowers are used for human consumption in New Zealand (Rangahau, 2002).

Leaves

Fresh leaves can be eaten in salads or as a green vegetable, often blanched to remove the bitterness. Dandelion leaves are a rich source of vitamin A and vitamin C. Dried leaves may be used in digestive or diet drinks and herb beers. The leaf is reputed to be similar in medicinal action to the root, but weaker (Rangahau, 2002).

Roots

Roots can be dried, then roasted and ground to make coffee substitute (Rangahau, 2002).

Flowers

Dandelion flowers can be used to make wine and syrup (Rangahau, 2002).

1.4.2.2.2 Food uses in America

Dandelion is approved as GRAS (generally recognised as safe) food ingredient in the USA. Extracts are used as a flavour component in various food products, including alcoholic (e.g. bitters) and non-alcoholic beverages, frozen dairy desserts, candy, baked goods, gelatines, puddings and cheese (Wildman, 2002).

Leaves

Dandelion greens are used in salads, sautéed or steamed. They taste like chicory and endive, with an intense heartiness overlying a bitter tinge. Mixed with other flavours, as in salads, dandelions improve the flavour. To camouflage the slight bitterness, dandelion is cooked with sweet vegetables, especially sliced carrots and parsnips (Wildman, 2002). Young dandelion leaves make delicious sandwiches, the tender leaves between slices of bread and butter and sprinkled with salt. The leaves are also used as source of vitamins A and C when harvested before the plants flower. They are cooked with water, vinegar or meat (Van den Heever, 1997).

Roots

The taproot is edible all year, but is best from late fall to early spring. Pre-boiling and changing the water, or long, slow simmering mellows this root. Sweet vegetables are used to complement dandelion roots. Sautéing the roots in olive oil also improves them, creating a robust flavour (Wildman, 2002). Dandelion roots are also roasted to form dandelion coffee. Dandelion coffee has become more into use in America and England, being obtainable at most vegetarian restaurants and stores. The roots are thoroughly cleaned, then dried by artificial heat, and slightly roasted until they have a tint of a coffee taste/aroma, when they are ground, ready for use. The prepared powder is said to be almost indistinguishable from real coffee, and is said to be an improvement to inferior coffee, which is often and adulterated product (Grieve, 1995). Dandelion coffee comes in chunks, granules, tea bags and even as instant beverage (Gail, 1997).

1.4.2.2.3 Food uses in England

Leaves

Dried leaves are employed as an ingredient in many digestive or diet drinks and herb beers; where dandelion stout ranks as a favourite. An agreeable and wholesome fermented drink is made from dandelion, nettles and yellow dock. The addition of a little lemon juice and pepper varies the flavour. The young leaves may also be boiled as vegetable, spinach fashion, thoroughly drained, sprinkled with pepper and salt, moistened with soup or butter and served very hot. A simple vegetable soup may also be made with dandelions (Grieve, 1995).

Roots

Roots are prepared in the same manner as was described for the USA. Dandelion coffee is a natural beverage without any of the injurious effects that ordinary tea and coffee have on the nerves and digestive organs (Grieve, 1995).

Flowers

Dandelion flowers are eaten, while in Berkshire and Worcestershire, the flowers are used in the preparation of a beverage known as dandelion wine. This is made by pouring 4 litres of boiling water over 4 litres of the flowers. After being well stirred, it is covered with a blanket and allowed to stand for three days, being stirred again at intervals, after which it is strained and the liquor boiled for 30 minutes, with the addition of 1.6 kg of loaf sugar, a little ginger sliced, the rind of 1 orange and 1 lemon sliced. Dandelion wine has been made from the flowers of dandelion for thousand years, and has developed a reputation as an excellent and unusual table beverage, as well as a fine medicinal drink good for purifying blood, and a tonic for the liver and kidneys (Gail, 1997; Grieve, 1995).

1.4 Status of Indigenous Vegetables in Africa

The production and utilisation of African Leafy Vegetables (ALVs) can make a much-needed contribution to improve nutrition and income in many African countries. The use and conservation of ALVs have been neglected over the last twenty years and there is a serious threat that many species will drop out of use in some areas if no appropriate counter-measures are taken (Shiundu, 2002). The neglect of ALVs, coupled with the increasing prices of food due to shortages portends an uncertain future for most African countries. The southern part of Africa is faced with a serious food shortage that threatens lives of millions of people, due to poor crop harvest experienced in the past years (Shiundu, 2002). ALVs should receive increasing attention from agriculturists and ecologists interested in sustainable production systems because they grow on soils of limited fertility, are relatively drought tolerant, provide good ground cover, and are usually cultivated without pesticides or fertilizer. Further, economically, ALVs are often considered a poor man’s crop, a perception that needs promotion to change consumer attitude. Regular intakes of these vegetables can provide the recommended daily amounts of certain vitamins and elements, for the underprivileged (Shiundu, 2002).

Edible wild plants have traditionally played a valuable role in the diet of the people of Lesotho. The production and utilization of indigenous vegetables make a much-needed contribution to improve nutrition and income. In recent times, however, their uses have been in decline, and are mainly consumed by the poor in rural areas. Most people, however, use cultivated vegetables, which are obtained from the roadside or the local stores. Edible wild plants are still crucial sources of food in the pre-harvest so-called 'hungry season' when food supplies are scarce or expensive and during famine or drought (Prasad *et al*., 1993).

1.5 Aims of the Study

Lesotho is a low-income, food deficit country characterised by a high degree of food insecurity and high malnutrition rates. The latest demographic data (Food and Nutrition Co-ordinating Office (FNCO, 2002) indicates that Lesotho is one of the countries in Africa with very high malnutrition rates, with 30.7% prevalence of stunting, 3.2% wasting and 15.4% underweight amongst children under five years of age. Chronic and acute malnutrition has been increasing over the past decade as is indicated by FNCO, 2002. This indicates that there is a poor feeding practice, accompanied by a variety of factors including a lack of the necessary resources for the production of food, hence, wild vegetables can perfectly substitute for the unavailability of such foodstuffs. The indigenous vegetables such as amaranth can offer variety in diet and in production systems, thus broadening the food base in Lesotho. The ecosystem in Lesotho contains a great variety of plants, which are locally consumed for their nutritional and medicinal properties. The nutritional and medicinal properties of these plants may be interlinked through phytochemicals, nutrient and non-nutrient, which they contain. The nutritional profile of these plants, in addition to their traditional applications, may find use as important ingredients in functional foods as well as new cash crops (Prasad *et al*., 1993).

The decline in the use of wild edible vegetables and fruits may be attributed to the low status and value which people attach to them, both in urban and rural areas. The status of indigenous leafy vegetables is not well documented hence there is a lot of research that need to be done on these plants. The use of wild plants is very common among the rural population in Africa and some of these species are also popular. Exotic vegetable species cannot be grown under harsh climatic conditions that are lately being encountered in many of the Southern African region. However there are a number of indigenous vegetables that can withstand harsh climatic conditions and alleviate the problem of food insecurity. In the study of Van den Heever (1997) it is stated that the use of wild plant foods in regions with low agricultural potential or during periods of drought contributes to food security and provides dietary supplements to the staple diet. In the previous discussions of this chapter it has been shown how some of these vegetables contribute to peoples' diet (amaranth and dandelion).

In order to study indigenous green leafy vegetables available and commonly consumed in Lesotho, the following aims are set:

1. To survey the uses of the green leafy vegetables indigenous in Lesotho
2. To evaluate perception of people towards consumption of wild green leafy vegetables
3. To collect and record wild green leafy vegetables, indigenous and commonly consumed in Lesotho
4. To analyse the nutritional value of selected green leafy vegetables indigenous in Lesotho
5. To assess possible new cash crops from the wild green leafy vegetables

CHAPTER 2

SURVEY ON THE KNOWLEDGE AND USES OF INDIGENOUS VEGETABLES IN LESOTHO

2.1 Introduction

Traditional vegetables in Africa have suffered from neglect by formal-sector agricultural and conservation institutions. The social and environmental conditions where they are grown have led to their relative neglect by development agencies as well. Many African traditional vegetables, particularly the leafy green vegetables, are weedy, semi-cultivated species, or crops requiring very little in the way of management and inputs. Kitchen and home gardens, fallows, watercourses, field margins and disturbed areas along the rows and watercourses are typical of the kinds of sites where these species are found (Eyzaguirre, 1997). Eyzaguirre (1997) further indicates that the rapid pace of social and cultural change suggests that the current neglect may soon translate into disuse and the eventual genetic erosion and loss of these vital nutritional and economical resources. These reasons and many others have led to the total neglect of these food plants both by the farming community and science. People use these plants (both urban and rural) on daily bases but have not attached any value to them thus do not even realise the need to establish conservation measures for these food plants.

The traditional wild food plants referred to in this study are not the staples like sorghum or maize, but they are eaten as accompanying relishes and sauces. Generally women and girls collect, prepare, store and market them. As traditional food plants, they are accepted by the community as appropriate and desired food resources, and also as home remedies for some ailments (Prasad *et al.*, 1993). People know how to protect, gather and prepare them and enjoy dishes prepared from them. Being so essential to the diet of the rural subsistence household, greater exploitation of these vegetables could significantly contribute to household food security in Lesotho, which is currently very low. Given their seasonal variation in their maturation, some plants are always available throughout the year (Prasad *et al.*, 1993).

The role of orally transmitted knowledge, in local communities is however diminishing as it is being replaced by the dominant western knowledge system (Shava, 1999). Traditional vegetables are all categories of plants whose leaves, fruits or roots are acceptable and used as vegetables by rural and urban communities through custom, habit and tradition. Before the introduction of exotic species, they were widely consumed, particularly during famines or natural disasters (Mnzava, 1997). Traditional vegetables play an important role in the society, especially the rural community that depends on them throughout the year. These vegetables as mentioned before, have the advantage of surviving the harsh climates, thus, being available in times of drought and hunger (Mnzava, 1997; Maundu, 1997)). Indigenous in this study refers to the wild plant species that have evolved in the area of study and/or introduced species, which due to long use have become part of the culture of a community.

The aims of this chapter therefore are:

1. To survey the uses of the green leafy vegetables indigenous in Lesotho
2. To evaluate perception of people towards consumption of wild green leafy vegetables

2.2 Materials and Methods

2.2.1 Study design

Three areas were selected according to their ecological representation, and from the three distinct districts, three villages were selected to represent the ecological zones. The three districts were Mohales’Hoek, Maseru and Leribe and the zones represented were mountains/highlands, lowlands and foothills respectively. The study was designed in such a way that there were three distinct activities as shown in figure 2.1. The first activity was administration of questionnaires, followed by collection of indigenous vegetables and finally the laboratory analyses of the collected vegetable samples. Collection and nutrient analyses of samples was divided into two levels; 1) the preliminary study and 2) secondary study. Figure 2.1 below gives the detailed outlay of the study.

A schematic outline of the study design

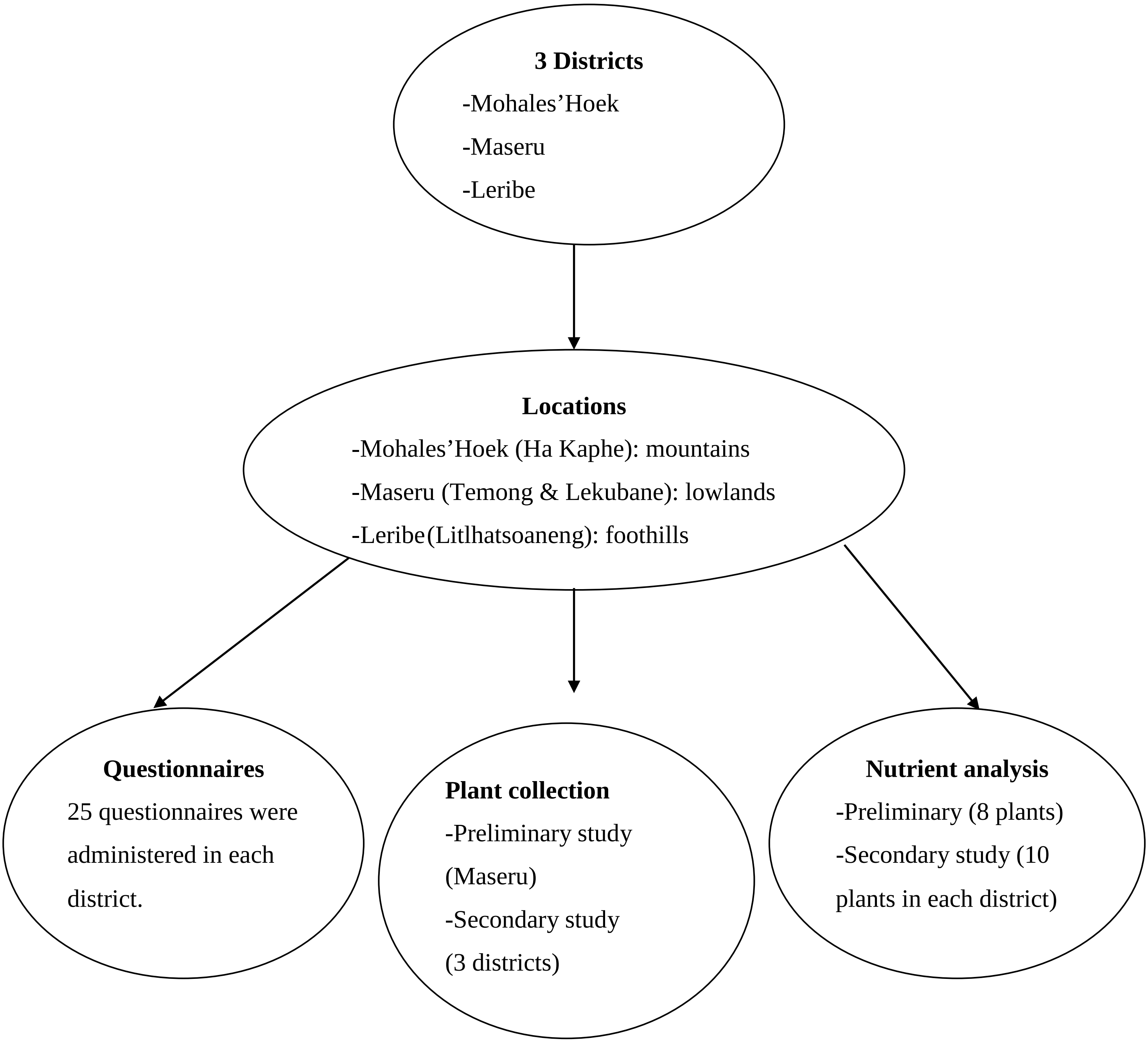

Figure 2.1 A schematic diagram of the study design

2.2.2 Questionnaire design

The questionnaire was designed in collaboration with the Department of Psychology, University of the Free State as they often deal with similar studies and are experts in social issues. A standardized interview was used for the purpose of offering each subject approximately the same stimulus, so that response to the questions, ideally, would be comparable (Berg, 1995). This type of information gathering tool was also used so that the administrator could familiarise herself with the study areas, as the same areas were to be used for vegetable collection. The aim of the questionnaire was to collect information about indigenous green leafy vegetables regarding their uses, as well as to establish whether they are used frequently enough to be candidates for development into cash crops. Questions were firstly designed in English and for easy and effective administration of questions, the questions were asked in Sesotho, and the two languages were used to note responses. After collection of data, the answers were translated into English for statistical analysis and interpretation of results. Most of the questions were open-ended questions, which were aimed to give room for detailed information on the green leafy indigenous plants. The questions were coded for statistical purposes after the survey. The questionnaire is presented in Appendix 1.

2.2.3 Questionnaire administration

2.2.3.1 Selection of study sites

All the four ecological zones of Lesotho needed to be covered, but due to time and financial constraints the coverage had to be limited to three. The zones were represented using only one village from each district. Ha Kaphe village (Mohales'Hoek district), Temong and Lekubane villages (Maseru district), and Lithlatsoaneng village (Leribe district) were selected to represent the mountainous/highlands (Southern part), lowlands (central) and the foothills (northern part) respectively. The selection criterion was that the selected villages had to be those with the highest occurrence level of indigenous vegetables. All the selected areas have been demarcated to be of the few places that still produce and consume edible indigenous plants in abundance (Prasad *et al.*, 1993). The same areas were also used for collection of vegetables for nutrient analysis in Chapter 4.

2.2.3.2 Sampling

A random sampling was used in the selection of participants in order to allow members of the community to participate, as everyone in the community is in a way involved in the knowledge and use of indigenous vegetables (Mnzava, 1997). The random sampling also assists with the in-depth information of these plants from different groups of people. Similar studies have however shown that the elderly are repositories of indigenous knowledge (Shava, 1999).

In each area 25 participants were interviewed without consideration of age, gender or financial status. The questionnaire administrator had to first report at the chief's place for approval to do house to house visitations. The questions were asked only to one member of the household to avoid repetition of information. Most of the participants were women, as most of the men are working, and women stay home to take care of the household activities. A file of dried pressed indigenous green leafy vegetables, obtained from the Lesotho Department of Agricultural Research (DAR) accompanied the administration of the questionnaire. A pre-selection of vegetables was done by reviewing literature on indigenous food plants known to be available in Lesotho (Prasad *et al*., 1993; Guillarmod, 1982). Forty (40) vegetable species were selected but only thirty (30) species could be found in the files. Respondents could identify all the 30 species during interviews and one extra species was mentioned, bringing the known vegetables to a total of 31 (see table 2.1).

Each participant was asked to browse through the file and identify indigenous vegetables that he/she knows, and then add them to the list of vegetables that do not appear in the file. The use of dried vegetable samples assisted participants to recall those vegetables that are no longer available in their areas. It should be noted that some of the plants could not be identified by their botanical names (Table 2.1), and their Sesotho names were therefore used.

2.2.4 Statistical analysis

The questionnaires were coded before the statistical analysis was done. Frequencies were calculated. To assess the statistical significance of an association between the two sets of attributes, the contingency coefficient (C) was computed (Bless and Kathuria, 1993). In the course of computing C, the Chi-square (χ^2) was first determined and tested for significance. Demographic data was analysed using frequencies. The recipe information was analysed by recording the number of vegetables (indigenous and exotic) and other foodstuffs that are mixed in a recipe. A table was compiled to present the traditional vegetables commonly mixed in vegetable preparation (Table 2.4).

2.3 Results and Discussion

2.3.1 Demographic details

A total of 75 participants were interviewed, with 25 participants in each location. Out of the whole population only 20% of the respondents were males and the rest females. Getting males to participate in the study was not easy, as most of the men and boys were out working in the larger centres. The few that were available for interview were also not easily convinced to take part, as they associate food issues as being feminine. The age of the participants ranged from 16 to 85 years, and this was grouped into four categories: 16 – 36, 37 – 57, 58 – 78 and 79 and above. These were grouped for the purpose of coding for data analysis. The highest number per age group interviewed was 16 – 36 years at 44% followed by 37 – 57 year at 41.3%. The least interviewed was 79 years and above (2.7%). Most of the respondents were not educated, where 50.7% were only trained up to primary school level and only 22% at a higher educational level.

2.3.2 Availability and use of indigenous vegetables

2.3.2.1 Food uses

There was a vast wealth of knowledge on wild food plants, their identification and use, amongst the participants. Table 2.1 shows frequencies and percentages of the identified, available and consumed indigenous vegetables in Lesotho, as recorded from the three surveyed districts. Data in table 2.1 is presented in “counts” and “%” where “counts” means the number of respondents in respect to the variable within the column and “%” means the percentage of respondents (X/75x100);

Where X = number of responses

75 = total respondents

Of all the thirty-one wild vegetables that were identified, *Amaranthus hybridus* and *Wahlengergia androsacea* are the best-known wild vegetables with the highest knowledge level of 93.35% identification, 90.7% and 93.3% availability, 85.3% and 91.7% consumption rate, respectively. Most respondents pointed out that they know *Amaranthus hybridus* because it is available in their gardens and on the roadside as weed but they use a lot of *Wahlengergia androsacea* because it is easily available, either collected or bought, and it also tastes good. Four known vegetables were not presented in table 2.1 (*Bobatso ba lipela, *Fukuthoane, *Dipcadi viride* and *Physalis peruviana*) because they were recognised only once, and they were neither available nor consumed. These vegetables are collectively presented in Table 2.1 as “others”. *Chenopodium album, Lipidium capense, Sonchus nanus, Sisymbrium thellungii, Rorippa nudiscula* and *Urtica dioca* were also well known among the respondents, within a range of 53.3% to 85.3%. *Diascia integerrima, Lithospermum cinereum* and *Mariscus usitatus* were the least known wild vegetables that were identified by less than 5% of the respondents, which means that they are not readily used in food. *Sisymbrium capense*, *Taraxacum officinale* and *Sonchus dregeanus* were also known but at lower than 50%.

The respondents commonly consume wild vegetables that are popular and available in their area. The only exception is *Lipidium capense*. *Lipidium capense* is known by many people (70.7%), and 61.3% of the respondents pointed out that this vegetable is available in their area, but only 28.4% of these respondents use the vegetable in their food. The common reason given for the low consumption rate was that it grows in awkward places such as a cattle kraal or next to toilets, and it also tastes very bitter. *Wahlengergia androsacea* and *Amaranthus hybridus* were still the predominantly available vegetables, and this is logical, as people will mostly know only what is available within their environment. The percentage of *Wahlengergia androsacea* remained constant both in known and available vegetables. Most of the vegetables were known but not available at the rate they were identified. Some of the species were not available at all even though they were known. The respondents pointed out that some of these food plant species are disappearing from their area. *Anchusa capcusis, Asclepias multicaulis, Cynachum virens, Lithospermum cireneum, Taraxacum officinale, Rorippa fluviatillis* and *Phahlo ea mofumahali were the least available plants with a less than 5% availability count.

Four (5.3%) respondents mentioned that they do not use indigenous vegetables. The reasons given were that it consumes too much of time to gather from the wild and that they rather preferred common exotic species in their diet. This percentage all fall in the age group 16 – 36 years. This indicates that young people are loosing interest in these plants. Consumption of indigenous vegetables in Table 2.1 was highly dependent on availability, except for *Lipidium capense. Lipidium capense* was highly available at 61.3% but its consumption was only 28.4%. The most consumed vegetables were *Wahlengergia androsacea, Amaranthus hybridus* and *Sonchus nanus* at 91.7%, 85.3% and 51.9% usage respectively.

2.3.2.2 Medicinal uses

Many respondents (57.3%) mentioned that they do not use indigenous vegetables for medicinal use. *Urtica dioca* was the popular plant used for medicinal purposes and it was commonly used to treat illnesses like hypertension and diabetes. Generally most people (64%) preferred using indigenous plants for food in their diets.

The contingency coefficient was calculated in Table 2.2 to measure the extent of association between the two sets of attributes (Locations and known; available; consumed and preferred vegetables). There was a relationship between locations and perceptions, knowledge, availability, consumption and preference of indigenous vegetables. Location and identified vegetables were highly related ($C = 0.3788$) at a significance level of $P < 0.001$ with 58 degrees of freedom. Preference had the highest association with locations than other attributes at $C = 0.4621$ at a significance level of $P < 0.001$ with 30% freedom. This means that location and consumption of vegetables are highly related. The least associated attribute to location was knowledge ($C = 0.3788$) at a significance level of $P < 0.001$.

Table 2.1 Record of known, available and consumed green leafy indigenous vegetables from the three districts of Lesotho; Mohales'Hoek, Maseru and Leribe

Vegetable (Botanical name)	Identified		Availability		Consumption	
	Count	%	Count	%	Count	%
Amaranthus hybridus (African spinach)	70	93.3	68	90.7	64	85.3
Anchus capcusis (Petle-kheme)	9	12	4	5.3	1	1.4
Asclepias multicaulis (Mankiling)	15	20	4	5.3	1	1.4
Asparagus denudatus (Seharane)	7	9.3	-	-	-	-
Chenopodium album (Goosefoot/Birdseed)	64	85.3	57	76	40	48.7
Citrullus lanatus (Wild watermelon)	3	4	-	-	-	-
Cynachum virens (Mololo)	13	17.3	1	1.3	-	-
Diascia integerrima (Malan'a konyana)	2	2.6	-	-	-	-
Lipidium capense (Peppercress)	53	70.7	46	61.3	21	28.4
Lithospemum cinereum (Mosala-suping)	3	4	1	1.3	-	-
Mariscus usitatus (Indian grass)	3	4	-	-	-	-
Nasturtium officinale (Watercress)	37	49.3	10	13.3	7	9.6
Papaver aculeatum (Wild poppy)	19	25.3	8	10.7	3	4.3

Vegetable (Botanical name)	Identified		Availability		Consumption	
	Count	%	Count	%	Count	%
Rorippa fluviatilis (Liababe)	6	8	1	1.3	-	-
Rorippa nudiscula (Papasane)	40	53.3	23	30.7	16	22
Sisymbrium capense (Wild mustard)	29	38.7	12	16	6	8.5
Sisymbrium thellungii (Wild mustard)	50	66.7	29	38.7	22	31.1
Sonchus dregeanus (Scatter plant)	25	33.3	9	12	8	11
Sonchus nanus (Ground thistle)	64	85.3	49	65.3	34	51.9
Taraxacum officinale (Common dandelion)	16	21.3	3	4	3	4.4
Trogopogon porrifollius (Jerusalem star)	14	18.7	5	6.7	3	4.2
Urtica dioca (Stinging nettle)	55	73.3	46	61.3	32	45.5
Wahlengergia androsacea (Hare-bell)	70	93.3	70	93.3	65	91.7
*Senthlokojane	6	8	-	-	1	-
*Lebili la terekere	12	16	6	8	4	5.3
*Phahlo ea mofumahali	3	4	-	-	-	-
*Naman'a noka	2	2.6	-	-	-	-
‡Others	4	5.3	1	1.3	-	-

∗Plants that could not be identified by their botanical names
‡Plants that were mentioned once (Bobatsi ba lipela, Fukuthoane, *Physalis peruviana* and Lephothoane)
All the plants are presented with their botanical names followed by their common names, it should be noted that the Sesotho names are used where there is no common name.

In table 2.2 it is shown that association between location and consumption is C = 0.4381. In the course of computing C, it was determined that χ^2 = 76.73, which has a probability of occurrence of less than 0.001 (appendix 2). It is therefore concluded that location and consumption of indigenous vegetables were highly related at alpha (P<0.001), as a result availability was also highly associated with location at the same level of testing. As it is mentioned below, consumption rate of vegetables depend on their availability.

Table 2.2 Association levels between vegetables as perceived by Basotho people and locations; (Mohales'Hoek, Maseru and Leribe).

Attributes	Chi- square (χ^2)	Contingency Coefficient (C)	Degree of Freedom	Alpha level
Known	115.42	0.3788	58	0.001
Availability	83.62	0.3940	40	0.001
Consumption	76.73	0.4381	32	0.001
Preference	56.47	0.4621	30	0.01

If C = 0 (no correlation exists)

Table 2.3 below shows consumption percentages of green leafy vegetables. Most of the respondents pointed out that they only use these vegetables when they are available, and this means they do not preserve them for off-season times. Most people use these vegetables once a month, with a percentage of 26.7. The respondents also pointed out that they mostly use cultivated vegetables for daily cooking and wild vegetables are mostly used by the poor during dry seasons when exotic species cannot survive. The reasons put forth by the respondents for not using wild vegetables as much as cultivated vegetables were as outlined below:

- Wild vegetables requires more time and energy to collect
- they shrink more when cooked

- they are associated with the rural poor population
- they are not easily available as most of them are disappearing.

It was also mentioned that the frequency of use of these plants depends on their availability and the number of plant species available also determines preference.

Almost all the respondents (97.3%) stated that they collect wild vegetables for themselves, if and when they are available in their area. Furthermore 24% of the respondents buy these vegetables from the street vendors or friends, who also collect from their fields or neighbouring South African fields to sell. Only 13.3% do get these plants for free from friends and relatives. There are some individuals who cross the river and collect from South Africa, even though what they are doing is illegal. They mentioned that the most popular vegetables they collected across the border were *Wahlengergia androsacea* and *Rorippa nudiscula* on their return they sell part of what they have collected. This practice was common in Leribe. The yield of these plants in terms of quantity was very high in the South African fields, and this may be due to less land stress.

Table 2.3 Consumption frequency of green leafy indigenous vegetables

Consumption frequency	Percentage (%)
Daily	22.6
Once a week	16.0
Once a fortnight	18.6
Once a month	26.7
Never use them	5.3
*Others	10.7

*Others mean those consumption frequencies that do not fall within specified periods

2.3.3 Use of indigenous vegetables in recipes

Table 2.4 displays information regarding the use of indigenous vegetables in recipes. There were eleven different indigenous vegetables that were commonly used in Basotho food preparation. Each vegetable is given a letter to represent it in a recipe. There are those vegetables that were either cooked on their own or mixed with other vegetables for a relish (*Amaranthus hybridus, Urtica dioca* and *Wahlengergia* *androsacea*). The rest of the vegetables as shown in Table 2.4 were mixed with either two or more other vegetables. It was found that not more than five different vegetables are included in one dish. The mixing of vegetables was done to either camouflage the bitter taste of some, or to increase the quantity of vegetable. As it was mentioned, the vegetables shrink when cooked. Commonly used exotic plants (spinach, cabbage etc.) were also used in the mixture for the same mentioned purposes. *Amaranthus hybridus* appears most in Table 2.4, which shows that it is the most preferred vegetable in recipes. The reason being that it does not have a bitter taste, is easy to collect and found in abundance when in season. Spices and fat (sunflower oil and animal fat) were also used in the recipes to enhance taste. Special ingredients often used were pumpkinseeds (powdered) and vegetable atchar.

The second most used vegetable was *Wahlengergia androsacea* followed by *Sisymbrium thellungii*. The least found vegetables in recipes were *Lipidium capense* and *Sonchus dregeanus,* as they were only listed once in collected recipes (Table 2.4). These vegetables were defined by respondents as very bitter and being only used during times of severe drought, especially *Sonchus dregeanus.* The roots of this vegetable are so deep that it is not easily affected by drought or burning of the veld. On the other hand *Lipidium capense* was noted to be bitterer than all the other plants and also grows in awkward places like the kraal and around toilets, thus most people do not prefer using it in their vegetable recipes. A drastic decline between its availability and consumption (Table 2.1) can be clearly explained by the above statement. Other vegetables that appeared few times in recipes were *Taraxacum officinale, Rorippa nudiscula* and *Sisymbrium capense*. These vegetables' geographical distribution was very low except for *Rorippa nudiscula* in Table 2.1 (4%, 30.7% and 16% respectively). The respondents also indicated these species to be some of the disappearing food plant species.

Table 2.4 Uses of indigenous vegetables in recipes

Occurrence	*Amaranth hybridus* **A**	*Chenopodium album* **B**	*Lipidium capense* **C**	*Taraxacum officinale* **D**	*Rorippa nudiscula* **E**	*Sisymbrium capense* **F**	*Sisymbrium thellungii* **G**	*Sonchus dregeanus* **H**	*Sonchus nanus* **I**	*Urtica dioca* **J**	*Wahlengergia androsacea* **K**
1	A	B								J	K
2	AB AG AI AJ AK	BA BC BK	CB				GA GJ GK	HK	IA IJ	JA JG JI JK	KA KB KG KH KJ
3	ABK AGK AGI AGE AKD AGJ AIK	BAK		DAK	EAG		GAK GAI GAE GAJ		IAG IAK	JAG	KAB KAG KAD KAI
4	AEGK AGJK				EAGK	FGJK	GAEK GAJK GFJK			JAGK JFGK	KAEG KAJK KFGJ
5	ABDIK ABDFK	BADIK BADFK		DABIK DABFK		FABDK			IABDK		KABDI KABDF

More than one letter per column indicates the amount and types of vegetables in the recipe

2.4 Conclusions

Most of the indigenous vegetables are well known by the Basotho people, but their use has declined due to their disappearance in the environment. Many factors were associated to this disappearance. People have also lost interest in traditional food, especially indigenous vegetables, due to various emerging western food habits that most people adopt. The young generation had little knowledge about indigenous plant species, which is evident from the number of young people that took part in the study, as well as the small number of vegetables they listed as being available to their area. This indicates that indigenous knowledge is not being passed to the young people.

Residents of Mohales'Hoek, Maseru and Leribe made use of approximately fifteen plants in their diet, which differed, from one area to another. It is evident that these plant species are not available in quantities and times needed by the people, otherwise the residents would be consuming these plants daily, as it has been indicated by some of the participants. Table 2.3 showed that only 22 % of the respondents use these food plants daily, these people pointed out that if the plants were available they would use them every day because they taste good. Despite the on-going introduction of newly developed exotic species, indigenous species still retained their popularity among residents and their hardiness to harsh climatic conditions was also mentioned. There was a higher percentage of people (917 %) (section 2.3.2) who preferred using indigenous vegetable species in their diet. The residents went as far as crossing the river into South Africa, just for collection of these food plants. This, and the fact that only 5.3% do not consume these plants at all, indicates how attached these people are to their indigenous vegetables. There were those vegetables that were available but not consumed by the residents due to issues mentioned in section 2.3.2. Besides using indigenous vegetables as a relish, they are also used for medicinal purposes. The choice for using these plants as medicine was to consume them raw. Common illnesses that are treated by these plants include high and low blood pressure and diabetes.

There was a correlation between identified, available, consumed and preferred vegetables and the locations. Location and preference of vegetable plants were related at a higher level than other attributes (Table 2.2). All the locations differed from each other in terms of availability of plants, although most of the vegetables were commonly found in each location. Also the methods of preparation of these vegetable species were more or less the same throughout the survey areas. The commonly used recipe was mixing two or more vegetables in a pot to enhance taste and/or increase quantity of the relish (Table 2.4). Most of the respondents complained about not having full access to these plants due to unavailability of their seed materials. As a result people have to walk long distances to gather these plants, but at the end of the day come home with little material to cook. The consumption rate of these vegetables was also not very high due to the problems mentioned in section 2.3.2. This indicates that conservation of these plants is a serious issue that should be dealt with.

The results of this chapter show the potential of indigenous species contributing to the nutritional arena of the community, especially the rural communities. It would therefore be very important to also look at the nutritional value of these plants, to determine whether introducing them to the market would contribute to the nutritional status of the people. If the people like these plants and it were within their food habits, then it would be good to encourage them use them. The next chapter will then look at the nutritional value of some of these plants.

CHAPTER 3

A TRIAL STUDY ON THE NUTRITIONAL VALUE OF FREQUENTLY USED INDIGENOUS GREEN VEGETABLES IN ONE AREA OF LESOTHO.

3.1 Introduction

The human population of Lesotho normally depends upon a number of edible indigenous plants to satisfy part of their nutritional requirements. These food plants can play an important role in the provision of essential nutrients and the composition of a balanced diet (Prasad *et al.*, 1993). Since the indigenous green leafy vegetables contribute a greater part in the survival and diets of many Basotho, it would be of great importance to document the contribution made by these vegetables in terms of their nutritional value. Although several reports have been published on the nutritional value of indigenous plants (Cook *et al.*, 2000), the database of their chemical and nutrient composition is far from being exhausted.

Vegetables are the sole source of vitamin C in the diet of many people (Wills *et al*., 1998). The composition, and thus the nutritional value, of the parts of a plant are influenced to a larger extent by their functions in the life of the plant. For example, the leaf is an actively working or metabolizing part of a plant and does not generally store energy nutrients. It is therefore low in energy value but high in many vitamins that function in its metabolic processes (Bennion and Scheule, 2004). Leafy vegetables may be generally characterized as being high in content of water and low in carbohydrates and calories, with only small amounts of protein and little or no fat. These vegetables' chief nutritive contribution is to provide vitamins and minerals, and they are particularly important sources of iron, vitamin A, riboflavin, folate and vitamin C. The greener the leaf, the higher its vitamin A value (Bennion and Scheule, 2004).

The nutritive value of both grain and vegetable amaranth has been extensively studied (Bressani, 1990; Pedersen *et al*., 1987; Teutonico and Knorr, 1985; Becker *et al*., 1981), however most wild and indigenous vegetables have been neglected in terms of scientific research especially nutritive value. The purpose of this chapter is therefore to contribute towards nutrient analysis of the commonly used green leafy indigenous vegetables. In this chapter only few samples were collected from one village in Maseru and analyzed, to obtain the preliminary results of the study. The aim of this chapter is therefore to find out if the frequency of availability and consumption of indigenous vegetables investigated in chapter 1, relate to their nutritional value.

3.2 Materials and Methods

3.2.1 Collection and identification of indigenous vegetables

3.2.1.1 Identification of plants

Identification of indigenous plants was carried out in co-operation with the Herbarium department from the Department of Agricultural Research (DAR) and Department of Plant Sciences of the University of the Free State. As is seen from Chapter 2 (Table 2.1), some of the vegetables could not be identified by their botanical names and the English/ common names were also not available for others. Only two vegetables in this chapter (Table 3.1) could not be given English/common names.

3.2.1.2 Selection of vegetables

Eight vegetable samples were selected from the survey of commonly consumed vegetables Chapter 2 (Table 2.1). At this stage there was not selection criterion used, as this was a preliminary study. All eight samples were subjected to proximate analysis (protein, fat and fibre), and only three commonly consumed vegetables were subjected to both vitamin and mineral analysis (Table 3.2). All the plant materials were gathered from their natural habitat, where the green leaves were collected from different parts of the collection area and composite sample were made.

3.2.1.3 Collection of vegetables

The collection of vegetables was conducted during the spring and summer season. Some of the samples had either over-reached their seasonal maturity and/or not yet reached their optimal maturity stage. One food science technician and a herbarium technician from DAR helped with the collection of fresh green leafy vegetables. Indigenous vegetables were collected from the two villages of Maseru, Temong and Lekubane.

As is the norm of the Basotho people, the collection team had to report to the chief of each village before starting work. Two or three people, mainly older women who had a broader knowledge on edible indigenous plants, helped with the identification of places with abundant plants as well as the Sesotho names of the plants during collection sessions. These people were very helpful, as they knew exactly where to find the plants and knew which places were safe to collect. For the purpose of this study the indigenous refers to the plant species that have either evolved in the area of study or have grown in the area for generations and are now considered indigenous.

3.2.1.4 Sample preparation

All the vegetable samples were stored in polyethylene plastic bags and stored in a cooler bag for transportation from the collection site to DAR. In the laboratory vegetables were sorted to remove plants with obvious damages, and then washed with tap water to remove soil particles, followed by a rinse with distilled water and drying on a mesh. After drying, the vegetables were stored frozen at –11°C in sealed polyethylene plastic bags until analyses were performed. Other samples were dried in an oven (for proximate and mineral analyses) at 105°C Storage time for fresh samples were less than a day for vitamin analysis. Composite powdered or shredded samples were prepared for the proximate and vitamin analyses respectively. Analyses were carried in duplicate (two analyses per sample).

3.2.2 Nutrient/chemical analysis

3.2.2.1 Protein determination

Crude protein was determined by using a Buchi-Kjeldahl method (AOAC method no.984.13, 2000). The protein content was determined in duplicates of approximately 0.5g vegetable sample. Digestion was carried out in 20 ml 98 % H_2SO_4 with one Buchi-kjeldahl catalyst tablet. A blank consisting of all reagents, but without plant material was included. NaOH (45 %) was added to the digested material, and ammonia gas was collected in 100ml 2% boric acid containing mixed indicator. The boric acid containing the ammonia was titrated with 0.1N H_2SO_4 to a grey-brown end-point. The nitrogen content was converted to protein content by applying a protein factor 6.25.

3.2.2.2 Fat determination

Fat was estimated using a hexane method (Official and tentative methods of the American Chemists Society, 1985). Approximately 2g of a sample was subjected to hexane extraction in a soxhlet flask. After the extraction the hexane was vaporized at 100°C, and the mass of the remaining substances determined as total fat.

3.2.2.3 Fiber determination

Fiber was determined by the acid detergent fiber method (Robertson and Van Soest, 1981). Approximately 1g of sample was subjected to acid digestion in sintered glass crucibles with acid detergent solution at 105°C for 12 hours. The samples were subsequently ashed at 500^0C for 4 hours and the mass of the remaining ash determined.

3.2.2.4 Vitamin C determination

The ascorbic acid (AA) content of vegetables was determined using 2,6 dichlorophenolindophenol method (AOAC, 2000). Standardization of indophenol solution was done with 10% trichloroacetic acid (TCA). Standard ascorbic acid (1mg/ml) was titrated to a pink end point. Approximately 5 g sample was subjected to extraction by grinding in a mortar with 10% TCA solution (Merck). The ground sample was filtered through Whatman filter paper no.1 and made to 100ml with TCA solution, of which 10ml was subjected to titration.

3.2.2.5 β-carotene determination

β-carotene was estimated by a simple spectrophotometric method (AOAC method 941.15, 2000). Acetone (Merck) was used to extract the β-carotene from approximately 2 g sample. The sample was chopped fine and ground in a mortar with 10ml acetone. Extraction was repeated three times. The extract was evaporated and the residue dissolved in approximately 2 ml petroleum ether (Merck), which was loaded onto a chromatographic column (1cm x 10cm) packed with 7 g silica gel. The β-carotene was eluted with 25ml petroleum ether, and the absorbance at 440nm determined with a UV-Visible spectrophotometer (Beckman Coulter).

A pure beta-carotene solution was made with concentrations 0,1.0,1.5 and 2.0 and their absorbency values were determined at 440 nm and plotted against these concentrations to give the standard curve (Figure 3.1). The same standard curve was used as a reference to calculate β-carotene for samples.

3.2.2.6 Mineral determination

Dry ashing and Atomic Absorption Spectrophotometry (AAS) were used to determine the mineral content of the plant material (AOAC method no.968.08, 2000). Approximately 5g of sample was ashed at 550°C for 18 hours. Ash was dissolved in 1N HCL, filtered through Whatman no. 1 filter paper and made to 100 ml. AAS was carried out at the Department of Soil, Crop and Meteorological Sciences of the University of the Free State. Fe, Zn, Mn, Ca and Mg were determined.

3.3 Results

3.3.1 Collection and identification of indigenous vegetables

Collection of plants was not very easy as some of the plants were very far from the village. At the time of collection some of the plants had already passed the desired maturity stage (flowered or seeded). Nevertheless, they were collected for analysis, but their seasonal occurrence was documented in Chapter 4 for future collection.

The sub-samples of each vegetable were pooled together to form a composite vegetable sample that was subjected to analysis. There were those plants that were very tender, which had just emerged from the soil and those plants that were over developed. The over developed plants were just starting to develop flower sprouts and their leaves were very hard to touch and/or dry leaf ends, thus having an effect on the plant nutrient composition. The same plant species had different maturity appearances at the same collection time. The results of this chapter will therefore be interpreted with caution.

3.3.2 Chemical analysis of plants

Table 3.1 displays the proximate analysis of the eight selected indigenous vegetables. The nutritional content of these vegetables is presented in $g.100g^{-1}$ of fresh sample. *Amaranthus hybridus* and *Sisymbrium thellungii* had the highest protein content of all the analysed vegetables with 28.09 $g.100g^{-1}$ and 27.44 $g.100g^{-1}$ respectively. *Sonchus nanus* contained the lowest protein content of all the vegetables, with 13.87 $g.100g^{-1}$. Looking at the trend in Table 3.1, the protein content of the vegetables was generally high. *Lipidium capense, Sonchus nanus, Sonchus dregeanus* and *Wahlengergia androsacea* have a relatively low protein content compared to previous discussed vegetables.

Sonchus dregeanus, Rorippa nudiscula and *Lipidium capense* showed a very high fiber content, ranging from 24.21 $g.100g^{-1}$ to 25.87 $g.100g^{-1}$, while *Wahlengergia androsacea* displayed a low fiber content of 11.15 $g.100g^{-1}$, which is not considered very low compared to literature (Kruger *et al*., 1998). *Sonchus nanus* and *Sisymbrium thellungii* showed the lowest fat content of all the vegetables. In his study, Zhu *et al*. (1999) showed the lowest fiber content of Chinese traditional and wild vegetables to be 0.26 $mg.100g^{-1}$, which is very low compared to that of *Wahlengergia androsacea*. It is worth noting that these results should be taken with caution as mentioned in section 3.2.1.1, especially for fiber content as vegetable fiber toughens when leaves mature. Generally *Amaranthus hybridus* performed very well in all the analyses whereas *Wahlengergia androsacea* was the least performer of all the vegetables.

Table 3.1 Proximate analysis (dry matter) of eight selected green leafy indigenous vegetables commonly consumed by Basotho people in the Maseru district (Temong and Lekubane villages).

Plant name		**Nutrient content (g.100g^{-1}) of plant**		
Botanical and common name	**Local name**	**Protein**	**Fibre**	**Fat**
Amaranthus hybridus (African Spinach)	Theepe	28.09	13.49	1.38
Chenopodium Album (Goosefoot)	Seruoe	24.65	13.37	2.23
Lipidium Capense Pepper cress)	Qhela	15.78	25.87	3.41
Rorippa nudiscula (Papasane)	Papasane	20.33	23.93	2.63
Sisymbrium thellungii (Wild mustard)	Sepaile	27.44	18.22	1.23
Sonchus nanus (Ground thistle)	Leshoabe	13.87	15.13	3.12
Sonchus dregeanus (Scatter plant)	Leharasoana	18.71	24.21	5.58
Wahlengergia androsacea (Hare bell)	Tenane	15.74	11.15	1.68

Figure 3.1 below shows the standard curve for β-carotene. This standard curve was plotted using a pure β-carotene solution and it was used to as a reference to calculate samples'β-carotene concentration. Table 3.2 shows β-carotene and vitamin C contents of the raw, fresh indigenous vegetables. Only three samples were analysed for these nutrients. *Amaranthus hybridus* had the highest vitamin C content and *Sonchus nanus* showed the lowest content of

the three samples. β -carotene content in *Amaranthus hybridus* and *Sonchus nanus* was slightly higher than that of *Sisymbrium thellungii.* Vitamin C in *Sonchus nanus* was relatively low as compared to the other two vegetables In Kruger et al., (1998), raw kale and spinach showed a vitamin C content of 120 $mg.100g^{-1}$ and 28 $mg.100g^{-1}$ respectively In general *Amaranthus hybridus* had higher vitamin values than the other two vegetables.

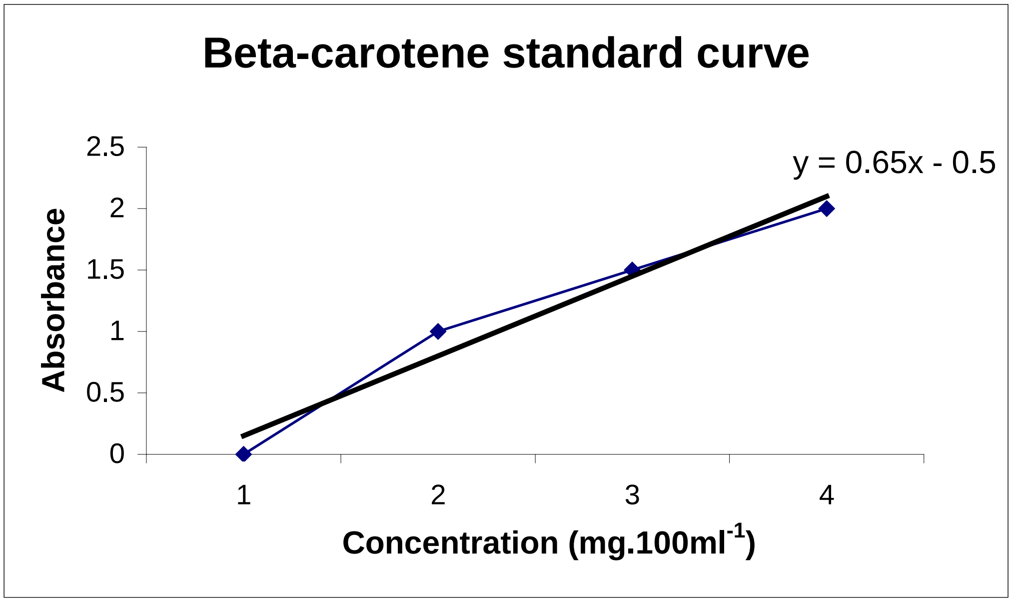

Figure 3.1 Beta-carotene standard curve

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Table 3.2 β-carotene and vitamin C content (fresh plants) of the three selected green leafy vegetables commonly used by Basotho people in Maseru district (Temong and Lekubane villages).

Sample Name		**Nutrient content (mg.100g^{-1})**	
Botanical and Common name	**Local Name**	**β-Carotene**	**Vitamin C**
Amaranthus hybridus (African spinach)	Theepe	4.94	85.8
Sisymbrium thellungii (Wild mustard)	Sepaile	3.76	49.4
Sonchus nanus (Ground thistle)	Leshoabe	4.36	23.4

Table 3.3 presents the mineral content of the three selected indigenous vegetables. The results of the analyses were computed to give nutrient values per 100 g of edible portion of fresh weight. Minerals were found to be high in nearly all the species analysed. In Chapter 1 (section 1.1) the literature stated that indigenous vegetables are good sources of minerals such as Ca, Mg and Fe (Madisa and Tshamekang, 1997). *Sisymbrium thellungii* was generally the best source of minerals with an exceptionally high calcium content (188.50 mg.100g^{-1}).

The highest amounts of iron were found in *Sisymbrium thellungii* (40.70 mg.100g^{-1}) and the lowest amounts were in *Sonchus nanus* by 11.00 mg.100g^{-1}. Manganese concentration was highest in *Sisymbrium thellungii* (9.45 mg.100g^{-1}) and *Sonchus nanus* presented the lowest manganese concentration (3.10 mg.100g^{-1}) fresh weight basis. Zinc concentration was the highest in both *Amaranthus hybridus* (6.60 mg.100g^{-1}) and *Sisymbrium thellungii* (4.95 mg.100g^{-1}). *Sonchus nanus* contained zinc less than 1mg.100g^{-1}. The highest amounts of potassium were found in *Sisymbrium thellungii* (341.50 mg.100g^{-1}) and the lowest amounts were in *Amaranthus hybridus* (207.30 mg.100g^{-1}).

Table 3.3 Mineral content of three selected green leafy indigenous vegetables commonly used in the Maseru district (Temong and Lekubane villages).

Sample		**Nutrient content (mg.100g^{-1})**				
Botanical and Common name	**Local name**	**Fe**	**Mn**	**Zn**	**K**	**Ca**
Amaranthus hybridus (African spinach)	Theepe	7.55	6.05	6.60	207.30	32.60
Sisymbrium thellungii (Wild mustard)	Sepaile	40.70	9.45	4.95	341.50	188.50
Sonchus nanus (Ground thistle)	Leshoabe	11.00	3.10	0.55	286.60	19.30

3.4 Conclusions

Selections of vegetable samples (8 for proximate and 3 for vitamins and minerals), as recommended in chapter 2, were analyzed for the purpose of comparing the vegetable usage and vegetable nutritional values. The nutritional value of the food plants analyzed was generally good, but it should be taken into account that plants were not at the same maturity stage during collection. The proximate analysis of plants was generally good with *Amaranthus hybridus*, *Chenopodium album* and *Sisymbrium thellungii* performing exceptionally well on protein content. *Sonchus dregeanus* had the highest levels of fiber and fat contents. *Amaranthus hybridus* had high levels of vitamin C and β -carotene contents (Table 3.2). The other two samples also showed good levels of vitamins in their leaves. All the analyzed vegetables had average vitamin content. *Sisymbrium thellungii* performed very well in all the minerals, with exceptional amounts of calcium (Table 3.3).

All the three plant samples that were analyzed in this chapter showed good popularity among Basotho people in chapter 2. *Amaranthus hybridus* and *Sonchus nanus* were consumed by not less than 50% and *Sisymbrium thellungii* was consumed by 31.1% of the respondents. This means that these plants have a great potential of being used to address the problem of malnutrition in these parts of the country, because they are nutritionally performing well and very much liked by the people in these two areas.

The results in Chapter 2 showed that there is a relationship in locations and identified available, consumed and preferred vegetable plants. In this chapter only a few vegetable types (8 samples for proximate and 3 for vitamins and minerals) were analyzed for their nutritional value (Protein, fat, fiber, vitamin C, beta-carotene and 5 minerals only), and only in one location. It would therefore be of value to look at the relationship between locations and nutritional value of these plants. There were other plants that were also very popular in Chapter 2 but were not analyzed for their nutritional value. The following chapter will therefore focus on the nutritional value of the same plants analyzed in this chapter plus those plants well known and used in Chapter 2. Collection of plants for analyses will be done in three locations, so that the relationship within localities and vegetables can be determined. The maturity level of the vegetables will be taken into account in Chapter 4, to ensure proper and valid comparison.

CHAPTER 4

A STUDY ON NUTRITIONAL VALUE OF FREQUENTLY USED INDIGENOUS GREEN VEGETABLES IN DIFFERENT AREAS OF LESOTHO

4.1 Introduction

Fruits and vegetables offer the most rapid and lowest cost method of providing adequate supplies of vitamins, minerals and fiber to people, especially the rural poor. Indigenous vegetables, such as amaranth and many others, remain popular especially in the rural areas of the country, where they are often considered more tasty and nutritious than exotic vegetables (McLeod, 2002). In the previous chapters indigenous plants that were frequently used were identified. Nutritional values were also determined, but it was found that the plant material was not harvested at their optimum condition.

In the current chapter the objectives to be addressed were:

- to analyse the nutritional value of selected green leafy vegetables indigenous in Lesotho,
- to use the nutritional information to assess some of the plants as possible candidates to be developed as new cash crops.

4.2 Materials and Methods

4.2.1 Study sites

The food plants were gathered from the three selected areas in Lesotho mentioned in the previous chapters, i.e. Maseru, Mohales'Hoek and Leribe. Collection was carried out during the spring and summer seasons. The maturity stage is critical and was taken into consideration at this phase of the research. The collection areas were visited several times to determine the optimal maturity stage of plants. Green leaves of the plants were collected for nutrient analysis as is shown below.

4.2.2 Seasonal occurrence

The seasonal occurrence of vegetables was determined before the collection. Collection of information on seasonal occurrence of vegetables was done through group interviews. A group of men and women were gathered (through the assistance of the responsible chief), and asked about the time of availability of plants in their area, for each district. The group interviews were very effective as ideas were sometimes different, but in many instances consensus was reached. In few instances where consensus was not reached, the ideas were put together and concluding or summarized information drawn.

4.2.1.1 Identification and selection of vegetables

Identification and selection of vegetables was done according to the methods described in Chapter 3, sections 3.2.1.1 and 3.2.1.2. As was determined in Chapter 2, the ten most consumed vegetables were collected for nutrient analysis (see Table 2.2). These plants were *Amaranthus hybridus* (African spinach), *Chenopodium album* (goosefoot), *Lipidium capense* (peppercress), *Nasturtium officinale* (watercress), *Rorippa nudiscula* (Papasane), *Sisymbrium capense* (wild mustard), *Sonchus dregeanus* (Scatter plant), *Sonchus nanus* (ground thistle), *Urtica dioca* (stinging nettle), and *Wahlengergia androsacea* (harebell). In chapter 2, Table 2.2, *Sysimbrium thellungii* was also identified as a frequently consumed vegetable, being used by 31.1% of the participants of the survey. This plant was not collected for the nutrient analysis because during the collection periods it was not available in two of the districts, i.e. Maseru and Leribe, due to the severe drought that was experienced in 2003 countrywide. Figures 4.1 to 4.10 show photographs of the indigenous vegetables used in the study.

Fig. 4.1 *Nasturtium officinale* (Watercress)

Fig. 4.2 *Chenopodium album* (Goosefoot)

Fig. 4.3 *Sysimbrium capense* (Wild mustard)

Fig. 4.4 *Urtica dioca* (Stinging nettle)

Fig. 4.5 *Sonchus nanus* (Ground thistle)

Fig. 4.6 *Sonchus dregeanus* (Scatter plant)

Fig. 4.7 *Rorippa nudiscula* (Papasane)

Fig. 4.8 *Amaranthus hybridus* (African spinach)

Fig. 4.9 *Lipidium capense* (Peppercress)

Fig. 4.10 *Wahlengergia androsacea* (Harebell)

4.2.1.2 Collection of vegetables

Collection of vegetables was conducted according to the methods described in Chapter 3, section 3.2.1.3. It was mostly the same people as in Chapter 3 that assisted in the collection of the ten vegetable samples from the study districts. It was, however, necessary to supplement 2 or 3 people as replacements. Initially two weeks were allocated for collection, but the time had to be extended by another 2 weeks mainly because the plants were not of a desirable maturity. As a result the areas had to be revisited several times to collect some of the plants. Collection and sample preparation procedures were the same as in Chapter 3, sections 3.2.1.3 and 3.2.1.4, except that the seasonal occurrence of the plants (Table 4.3 to 4.5) was determined in consultation with the local people for timely collection.

4.2.2 Nutrient/chemical analysis

The contents of protein, fat, fiber, vitamin C and β-carotene, and the minerals Fe, Zn, Mn, Ca, and K were analysed by the procedures described in Chapter 3. The determination of ash content was added and carried out as described below. The two minerals Na and Mg were added to the list of minerals determined by atom absorption spectroscopy. Composite powdered or shredded samples were prepared for proximate and vitamin analyses respectively and analyses were carried out in duplicates.

Ash content of the vegetable samples was determined using the dry ashing method (AOAC, 1995). The oven dried vegetable samples were ground to pass a sieve of mesh size no.1. The constant weight of crucibles was obtained and approximately 2g of a sample was incinerated in the crucibles at 550°C overnight (ca 18 hours). The crucibles were cooled before the mass was determined. Ash content was determined as percentage of the dry material.

4.2.3 Statistical analysis

The data was analysed using Proc GLM of SAS (1991). The experimental design was a one-way ANOVA with treatments organized as a 3X10 factorial experiment. The main factors were the three locations and the ten vegetables, with interaction of location by vegetable. The interactions, when significant, were analysed using Tukey's method of multi comparisons between means (Appendix 3).

4.3 Results and Discussion

4.3.1 Seasonal occurrence of indigenous vegetables from the three districts.

Table 4.1, 4.2 and 4.3 shows the seasonal occurrence of green leafy vegetables from the three districts of Lesotho: Mohales'Hoek, Maseru and Leribe. The results will be discussed district by district. The purpose of these tables is to indicate times of high or low availability of indigenous vegetables and whether they are preserved or not. The flowering times are also indicated for more plants. It should be indicated that it was not easy to collect information on flowering times and seed bearing times, as most of the residents of these areas could not state the exact times. Hence the times at which seeds were available are not indicated in these tables.

Table 4.1 displays seasonal occurrence of the plants for the mountainous part of the country. Most of the vegetables are not available during winter season due to low temperatures and snow that is experienced in this part of the country. *Sonchus dregeanus* and *Urtica dioca* were the only plants that show capability to survive for more than six months in this area. It was indicated by the respondents that *Urtica dioca* can be available throughout the year if the climatic conditions are good, i.e. no severe drought or too much snow/rain. This plant flowers in March but people still collect its leaves until new plants emerge from the soil that is if weather conditions are good, meaning normal distributed rainfall. Unlike in the other two districts *Sonchus dregeanus* is not hardy enough to survive the extreme low temperatures. The highlands are also different from the other two areas by not having preserved indigenous vegetables. The people in this area mentioned they only preserve exotic species, as they are easily available in larger quantities. *Lipidium capense, Nasturtium officinale* and *Wahlengergia androsacea* were available fresh for only three months of the year and they were the plants that were reported to be disappearing.

Table 4.2 presents the occurrence of indigenous vegetables in the lowlands of the country, Maseru taken as the representative. In this area there are vegetables that are preserved for the off-season or dry periods. This is the warmest part of the country and there are plants like *Sonchus dregeanus* and *Sonchus nanus* that are available throughout the year if the weather conditions are good. Most of the plants are available for many months of the year, unlike in Mohales'Hoek. *Amaranthus hybridus, Chenopodium album, Urtica dioca* and *Wahlengergia androsacea* were the vegetables that occurred in the lowest amounts. Most of the vegetables are commonly found fresh from October to December.

Table 4.3 is not very different from table 4.1, except that the gaps within the winter season months is bigger here. Most of the vegetables are not available fresh in winter and they occur fresh predominantly from October to December. There are only two vegetables that were not available fresh during the October – December period, i.e. *Chenopodium album* and *Wahlengergia androsacea*. These vegetables are only available preserved (dried). *Sonchus nanus* was the most abundant fresh vegetable available in this area.

Table 4.1 Seasonal occurrence of ten commonly consumed green leafy indigenous vegetables in Mohales'Hoek; representative of the mountains.

Vegetable name (Botanical and Common)	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Amaranthus hybridus (African spinach)	A	F								A	A	A
Chenopodium album (Goosefoot/pigweed)	A	F								A	A	A
Lipidium capense (Pepper cress)		F								A	A	A
Rorippa nudiscula (Papasane)	A	A	F							A	A	A
Sysimbrium capense (Wild mustard)	A	A	F						A	A	A	A
Sonchus dregeanus (Scatter plant)	A	A	A					A	A	A	A	A
Nasturdium officinale (Watercress)	F									A	A	A
Sonchus nanus (Ground thistle)	A		F	F					A	A	A	A
Urtica dioca (Stinging nettle)	A	A	A/F	A						A	A	A
Wahlengergia androsacea (Harebell)		F	F							A	A	A

A – available fresh F – start flowering P – available preserved

Table 4.2 Seasonal occurrence of ten commonly consumed green leafy indigenous vegetables in Maseru; representative of the lowlands.

Vegetable name (Botanical and Common)	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Amaranthus hybridus (African spinach)	A	A	F	F					A	A	A	A
Chenopodium album (Goosefoot/pigweed)	A	A	F	F					A	A	A	A
Lipidium capense (Pepper cress)	P	P		A	A	A	F	F		P	P	P
Rorippa nudiscula (Papasane)	A	A	A	F	F			A	A	A	A	A
Sysimbrium capense (Wild mustard)	F	F					A	A	A	A	A	A
Sonchus dregeanus (Scatter plant)	A	A	A	A	A	A	A	A	A	A	A	A
Nasturtium officinale (Watercress)	A		F	F	F				A	A	A	A
Sonchus nanus (Ground thistle)	A	A	F	F		A	A	A	A	A	A	A
Urtica dioca (Stinging nettle)	A		F	F	F	P	P	P	A	A	A	A
Wahlengergia androsacea (Harebell)				A	A	A	F	F	P	P	P	P

A – available fresh   F – start flowering   P – available preserved

Table 4.3 Seasonal occurrence of ten commonly consumed green leafy indigenous vegetables in Leribe district; representative of the foothills.

Vegetable name (Botanical and common)	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Amaranthus hybridus (African spinach)	A	A	A	F	F						A	A
Chenopodium album (Goosefoot/pigweed)	A	A	A	F	F					A	A	A
Lipidium capense (Pepper cress)		A	A	A	F	F				P	P	P
Rorippa nudiscula (Papasane)	A	A	F	F	F		P	P	P	A	A	A
Sysimbrium capense (Wild mustard)	F								A	A	A	A
Sonchus dregeanus (Scatter plant)	A	A	A	A	A					A	A	A
Nasturtium officinale (Watercress)	F	F	F					A	A	A	A	A
Sonchus nanus (Ground thistle)	A	F	F						A	A	A	A
Urtica dioca (Stinging nettle)	A	A	F	F						A	A	A
Wahlengergia androsacea (Harebell)					A	A	F		P	P	P	P

A – available fresh ***F – start flowering*** ***P – available preserved***

4.3.2 Effect of location on nutrient content of vegetables

Tables 4.4 and 4.5 show the nutrient content means and their standard deviation for the three districts. Figures 4.11 to 4.16 show differences in proximate and vitamin content of vegetables in the three districts of Lesotho.

In the figures the vegetables are identified by numbers as follows:

1 = *Nasturtium officinale* (Watercress)	2 = *Chenopodium album (*Goosefoot)
3 = *Sysimbrium capense* (Wild mustard)	4 = *Urtica dioca* (Stinging nettle)
5 = *Sonchus nanus* (Ground thistle)	6 = *Sonchus dregeanus* (Scatter plant)
7 = *Rorippa nudiscula* (Papasane)	8 = *Amaranthus hybridus* (African spinach)
9 = *Lipidium capense* (Peppercress)	10 = *Wahlengergia androsacea* (Harebell)

The multiple comparison of means was performed using Tukey's studentized range method and the results are presented in Appendix 3. Interactions between location and vegetable species were significant. Interpretation of the results for main factors (location and vegetable species) alone could be misleading and must be investigated and interpreted carefully with emphasis on the results of the interaction effects as given in Appendix 3.

4.3.2.1 Proximate and vitamin content of vegetables in locations

In Table 4.4 it is evident that all the vegetables had substantial amounts of protein ranging from 17.6±0.12 to 36.3±0.31 for *Sonchus nanus* (vegetable no. 5) and *Lipidium capense* (no. 9) respectively. In comparison, spinach and amaranth leaves have been documented to have a protein content of 2.9 $g.100g^{-1}$ and 24.8 $g.100g^{-1}$ respectively (Kruger *et al*., 1998). USDA (1999) shows that dandelion has a protein content of 2.7 $g.100g^{-1}$. The current research therefore shows that all ten vegetables are good sources

Table 4.4 Proximate (g.100g^{-1}) and vitamin means (mg.100g^{-1}) (±standard deviation), of green leafy vegetables in three districts of Lesotho.

Nutrient	*Nasturtium officinale*	*Chenopodium album*	*Sisymbrium capense*	*Urtica dioca*	*Sonchus nanus*	*Sonchus dregeanus*	*Rorippa nudiscula*	*Amaranthus hybridus*	*Lipidium capense*	*Wahlengergia androsacea*
	Vegetable type M/Hoek									
Protein	34.0±0.098	31.5±0.00	30.9±0.06	28.8±0.00	28.6±0.04	20.2±0.04	24.1±0.19	27.5±0.08	36.3±0.31	20.01±0.07
Fat	3.4±0.12	2.6±0.49	0.9±0.18	3.1±0.18	4.8±0.37	7.9±0.06	3.6±0.19	3.7±0.17	2.6±0.00	3.7±0.16
Fiber	16.9±0.21	11.2±0.12	15.7±0.69	13.1±0.63	11.0±0.04	19.0±1.01	12.5±3.01	14.1±0.34	15.5±0.15	17.5±1.15
Ash	15.0±1.4	22.5±1.51	17.6±0.50	25.5±0.23	22.0±0.11	15.1±0.37	19.4±0.63	23.9±0.47	14.8±0.82	20.6±0.44
Vitamin C	22.0±0.00	22.1±0.07	27.6±7.81	24.8±3.90	14.0±2.98	11.3±0.42	20.7±5.85	27.6±0.03	19.3±3.86	18.9±0.54
β-Carotene	4.2±0.18	6.37±0.12	3.9±0.08	9.5±0.05	4.9±0.03	4.6±0.06	8.1±0.05	5.2±0.10	3.1±0.04	4.6±0.06
	Maseru									
Protein	24.6±0.62	32.2±0.17	29.7±0.07	31.0±0.08	18.1±0.09	20.9±0.07	26.2±0.04	28.2±0.03	36.2±0.00	19.6±0.07
Fat	4.6±0.21	4.9±0.15	2.5±0.01	5.0±0.18	8.0±0.01	7.9±0.01	2.9±0.21	4.2±0.18	2.5±0.07	8.3±0.06
Fiber	20.9±2.33	9.6±0.13	14.0±0.09	12.7±0.43	24.8±0.67	20.9±0.39	12.5±0.02	10.7±0.85	13.9±1.65	10.9±0.13
Ash	12.5±0.66	16.3±0.64	17.2±0.22	17.3±0.06	24.5±0.73	23.6±0.60	15.4±0.14	16.9±0.06	17.5±0.53	16.6±0.29
Vitamin C	16.6±3.90	27.6±0.00	22.1±0.04	27.5±0.13	5.5±0.00	20.6±0.00	26.2±1.95	22.1±0.03	11.1±3.95	15.3±1.78
β-Carotene	3.6±0.52	7.3±0.33	4.2±0.01	10.6±0.01	5.0±0.04	4.8±0.02	9.2±0.05	6.3±0.04	3.2±0.028	4.7±0.05
	Leribe									
Protein	34.8±0.30	31.3±0.46	28.7±0.02	30.1±0.29	17.6±0.12	21.3±0.01	26.0±0.05	27.1±0.06	36.3±0.05	19.5±0.15
Fat	3.5±0.02	4.6±0.02	2.0±0.05	4.6±0.18	6.5±0.00	7.3±0.19	1.9±0.18	3.4±0.17	2.4±0.19	7.4±0.02
Fiber	18.9±1.03	9.1±0.15	13.9±0.18	14.6±1.09	25.3±0.45	23.5±0.00	11.7±0.32	10.0±0.54	14.6±0.71	15.8±0.23
Ash	15.8±0.32	15.1±0.32	23.6±0.00	17.2±0.49	27.3±1.05	25.5±2.35	15.2±1.44	23.6±0.45	17.7±0.21	16.2±1.05
Vitamin C	12.4±1.95	27.6±0.00	19.3±0.00	15.7±1.23	22.1±0.06	22.1±0.00	13.8±0.05	15.5±0.00	14.6±1.94	16.0±0.28
β-Carotene	3.3±0.01	7.0±0.06	4.0±0.04	9.3±0.05	4.9±0.04	4.2±0.04	8.9±0.07	6.4±0.04	4.1±0.23	4.1±0.01

of protein. *Lipidium capense* (no. 9) had the highest protein content for all three locations followed by *Nasturtium officinale* (no. 1) in Maseru and Leribe districts (Figure 4.11). The lowest protein content was observed in vegetables from Mohales'Hoek and Leribe for *Sonchus nanus* (no. 5) as is shown in Figure 4.11. The multiple comparison of means shows that there was a significant difference between the means (P<0.05) (Appendix 3). From Figure 4.11 it is evident that there is an interaction between vegetable and location regarding protein content, which means that a certain vegetable will not have a specific protein content in all locations, and that not all vegetables will deliver the same difference in protein content between them over the locations.

There were few variations in the multiple comparison location means and vegetable means (Appendix 3). Maseru gave the highest fat content in almost all the vegetables compared to the other districts. In the same manner the fat composition of vegetables varied greatly in the three districts. Generally Mohales'Hoek had the lowest fat content for all the vegetables with *Sisymbrium capense* (no. 3) and *Rorippa nudiscula* (no. 7) having the lowest amounts 2.0 $g.100g^{-1}$ and 1.9 $g.100g^{-1}$ respectively. However similarly to the protein content, an interaction between vegetable type and location was observed for fat content (Figure 4.12) *Sisymbrium capense* (no. 3) generally had the lowest fat amounts. The highest fat content was observed in Maseru for *Wahlengergia androsacea* (no. 10), followed by *Sonchus nanus* (no. 5) and *Sonchus dregeanus* (no. 6). These figures were considered to be comparatively high, as literature shows that spinach and amaranth contain 0.4 $g.100g^{-1}$ and 1.5 $g.100g^{-1}$ fat respectively (Kruger et al., 1998). In chapter 1 (Tables 1.1 and 1.3) it is shown that amaranth and dandelion contain fat contents of 8.03 $g.100g^{-1}$ (highest species) and 0.79 $g.100g^{-1}$ respectively. The difference in the mean variation was observed in some of the means (P<0.05) (Appendix 3).

The same trend of interaction between vegetable means in different locations was observed in fiber components (Figure 4.13). Vegetables showing the highest fiber content were *Sonchus nanus* (no. 5) from Maseru and Leribe, and *Sonchus dregeanus* (no. 6) for all the localities, *Chenopodium album* (no. 2) from Leribe had the lowest fiber content as

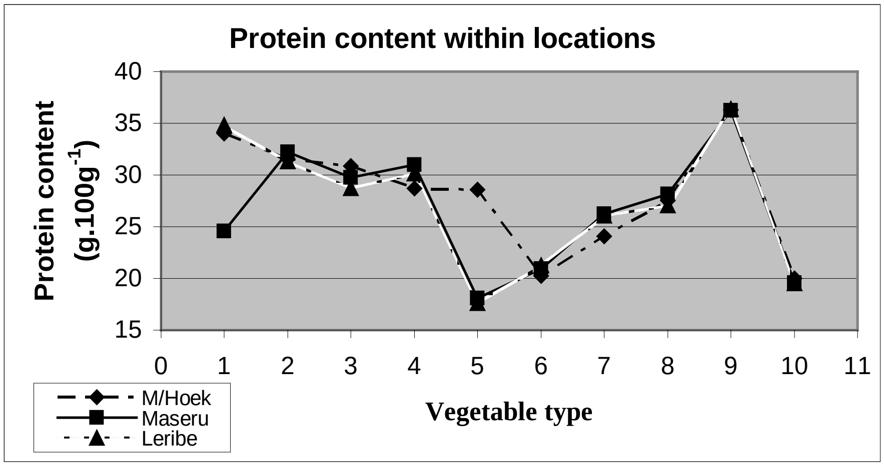

Figure 4.11 Protein content of vegetables across locations

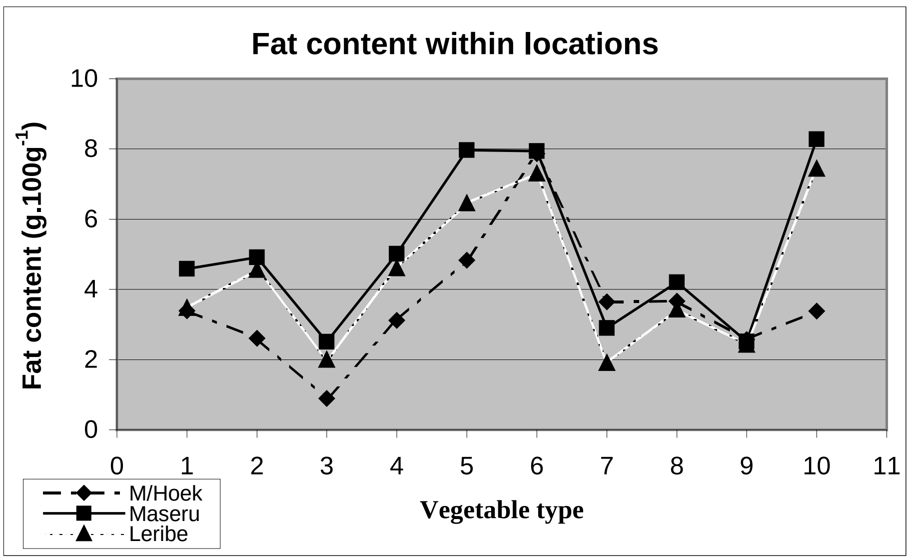

Figure 4.12 Fat content of vegetables across locations

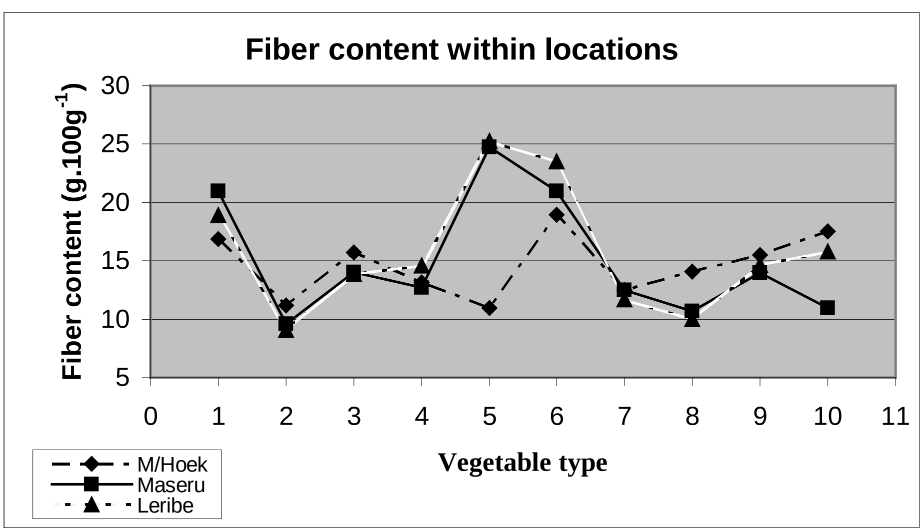

Figure 4.13 Fiber content of vegetables across locations

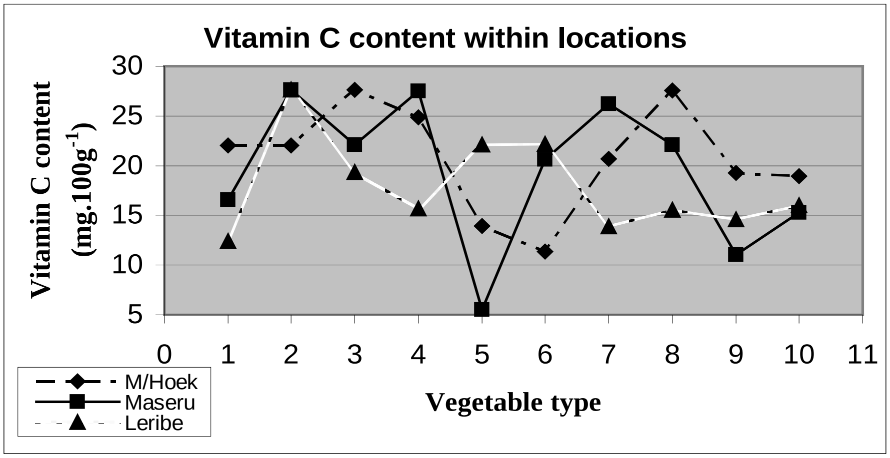

Figure 4.14 Vitamin C content of vegetables across locations

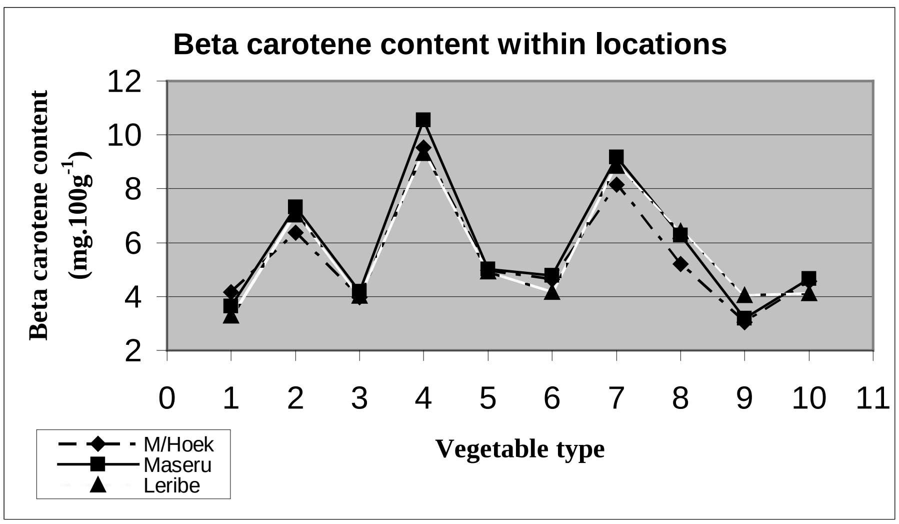

Figure 4.15 Beta-carotene content of vegetables across locations

compared to all ten vegetables and three localities (9.1±0.15). The proximate (protein, fat and fiber) content of amaranth as shown in Chapter 1 (Tables 1.1 and1.2) is lower than that obtained in Table 4.4, thus indicating that indigenous vegetables analysed in this study have a high nutritional value, especially in protein content.

The variation between the means of the vitamin C content (Table 4.4) was very high for some of the vegetables, as was the interaction between vegetable type and location. *Sonchus nanus* (no. 5) from Maseru contained 5.5 $mg.100g^{-1}$ and the *Urtica dioca* (no. 4), 27.6 $mg.100g^{-1}$. This high variation might be due to the susceptibility of vitamin C to degrade quickly after harvest. Although greatest care was taken to analyse the vitamin C content as soon after collection as possible, it sometimes happened that the analysis was delayed by a day. It is also possible that the delayed ripening time due to the drought could have resulted in these differences. Nevertheless, there are differences in the vitamin C content between the different plants. The vitamin C content of *Sonchus nanus* (no. 5) for instance is highly significantly different from that of *Urtica dioca* (no. 4) ($P<0.05$) (Appendix 3). Furthermore, plants contained between 5.5 and 27.6 $mg.100g^{-1}$ of vitamin C content, which falls within the range of that of green vegetables, such as spinach, with 28.0 $g.100g^{-1}$ (Zhu *et al*, 1999)

The β-carotene content of vegetables from Maseru was generally higher than in M/Hoek and Leribe, especially for *Chenopodium album* (no. 2), *Urtica dioca* (no. 4), and *Rorippa nudiscula* (no. 7). The highest β-carotene levels were observed in *Urtica dioca* (no. 4) and *Rorripa nudiscula* (no. 7) whereas the lowest levels were shown for *Nasturtium officinale* (no. 1), *Sisymbrium capense* (no. 3) and *Lipidium capense* (no. 9). The multiple comparisons of the means are given in Appendix 3. According to Hels *et al*., (2003) amaranth leaves contain 1.5 $mg.100g^{-1}$ of β-carotene, which is lower than the lowest result for the African amaranth (*Amaranthus hybridus*) (vegetable no. 8 in Table 4.2), which is 3.7 $mg.100g^{-1}$. Nasamvuni *et al*., (2001) found the A*maranthus hybridus* (no. 8) β-carotene content to be 6.23 $mg.100g^{-1}$, which falls within the range of the current study (3.1 mg.100g-1 to 10.6 $mg.100g^{-1}$). Although all plant performed well in all the three districts, there is an interaction between the vegetable types and the location.

Table 4.5 Mineral content (mg.100g^{-1}dried weight basis ±standard deviation) of green leafy indigenous vegetables in three districts of Lesotho.

Nutrient	Vegetable type M/Hoek									
	Nasturtium officinale	*Chenopodium album*	*Sisymbrium capense*	*Urtica dioca*	*Sonchus nanus*	*Sonchus dregeanus*	*Rorippa nudiscula*	*Amaranthus hybridus*	*Lipidium capense*	*Wahlengergia androsacea*
Fe	52.2±2.99	32.8±0.78	19.2±0.58	63.9±0.58	25.7±0.76	31.4±0.42	43.3±1.56	58.1±2.62	29.1±3.55	27.3±4.10
Zc	6.2±0.64	10.9±2.99	3.2±0.11	7.8±0.04	5.9±0.09	5.5±0.07	4.3±0.18	6.5±0.07	8.2±2.86	7.1±1.34
Mn	7.6±0.92	3.8±0.31	8.9±0.23	10.7±0.42	11.3±0.79	6.3±0.17	5.1±0.14	5.3±0.04	10.7±1.27	9.1±1.28
Na	61.2±15.41	23.5±0.18	45.9±0.00	24.1±0.10	39.9±0.43	26.2±4.13	42.9±1.58	53.9±0.57	54.7±3.13	40.3±0.04
Ca	1671.6±91.4	1639.2±10.29	1736.2±0.23	2371.2±0.01	1419.5±27.59	2953.7±372	1649.5±20	1858.2±59	1651±340	2580.4±0.57
K	2663.7±23.9	3304.8±40.35	2559.5±32.6	2604.2±65.1	4958.8±229.4	2797.6±31.0	2423.8±51	3072.1±87	3950.±1059	4794.5±7.81
Mg	294.7±36.34	505.1±128.55	535.9±28.15	628.2±24.49	306.6±10.01	454.8±8.53	523.1±0.5	751.9±68.8	412.9±2.91	301.7±1.09
	Maseru									
Fe	32.5±3.54	59.1±0.85	26.7±3.23	25.7±1.70	63.2±1.67	63.4±3.50	27.2±1.53	28.2±4.73	34.1±2.35	45.0±1.15
Zc	8.8±3.32	5.5±2.58	5.9±0.28	6.0±0.07	8.1±0.75	8.3±0.74	5.3±1.15	7.1±2.10	8.4±0.04	3.0±1.19
Mn	10.1±0.09	8.7±2.93	9.2±0.31	12.1±0.11	10.6±0.04	11.0±0.15	10.7±0.89	6.7±0.64	7.3±0.87	4.2±0.83
Na	61.2±15.2	23.5±0.18	45.9±0.00	24.1±0.09	39.9±0.43	26.2±4.13	42.9±1.58	53.9±0.57	54.7±3.13	40.26±0.04
Ca	1542.8±107	1037.1±17.15	1610.2±42.7	1442.5±10.6	1440.8±11.25	1760.5±0.61	1235.3±41	1935.2±27	1832.3±47.1	3271.7±94.26
K	2150.5±0.74	2529.6±87.08	4630±42.49	5275±35.36	1138.5±20.02	2873.2±297	4628.9±29	2834±101	2795.7±9.61	2326.7±32.89
Mg	363.1±60.47	468.2±90.22	294.1±11.87	308.5±2.12	783.3±14.62	599.4±20.38	395.9±83	368.9±152	493.6±57.53	497.2±31.4
	Leribe									
Fe	22.2±2.59	36.3±13.00	28.1±2.72	37.7±0.69	53.5±1.07	32.3±1.26	22.2±0.08	19.4±0.99	29.8±0.59	21.4±3.67
Zc	3.7±0.52	7.6±4.00	2.6±0.57	6.6±3.01	6.3±0.45	7.3±1.88	3.9±0.09	3.2±0.06	8.8±0.03	3.7±0.62
Mn	7.9±1.52	5.3±0.31	6.0±0.56	7.3±1.63	8.2±0.02	11.5±1.57	8.4±0.13	9.7±0.59	12.2±0.01	9.1±0.25
Na	81.1±0.00	55.1±20.55	34.8±0.11	62.4±3.5	55.0±7.00	61.7±0.29	39.3±0.00	39.4±0.28	57.5±1.29	36.7±2.33
Ca	1589.6±317	1240.1±325	1502.8±3.18	1663.4±70	1616.4±157.5	1290±304.1	2813±4.06	2229.6±8.3	2099.8±1.15	3301.9±89.2
K	2243.5±150	2438.3±48.56	2194.5±7.74	2972.3±134	2616.8±23.80	5051.5±492	2114±0.14	2376±18.5	4603.3±0.91	2349.1±1.23
Mg	182.6±88.28	232.1±20.8	406.0±9.87	589.6±0.73	326.9±11.4	620.4±27.7	662.7±5.7	523.6±0.04	515.5±6.56	479.2±48.4

4.3.2.2 Mineral content of vegetables in locations

The ash content of vegetables (Table 4.4) was exceptionally high. According to Hels *et al*., (2003); Kruger *et al*., (1998), amaranth has an ash content of 18.4 $g.100g^{-1}$ and 20.7 $g.100g^{-1}$ respectively, which falls in the range of results displayed in Figure 4.16.

Table 4.5 shows the mineral profile of ten vegetables with their standard deviations. Much greater differences in the contents of ash and mineral contents of the vegetables are observed between the locations (Figures 4.17 to 4.23) than for the proximate components already discussed. This is not surprising, as it is known that these are highly affected by almost all agricultural aspects such as plant cultivars, location, soil type, agricultural practices, rainfall, use of irrigation and possibly temperature (Kawashima and Soares, 2003; Glew *et al*., 1997). It can furthermore be seen clearly in these figures that the mineral content is not consistently high or low for a specific location, but varies depending on the vegetable species. This inconsistency gives rise to the interaction between location and individual species being significant. The differences in mineral content will therefore not be discussed in more detail, only that the mineral content of the studied vegetables are within the same order of magnitude as that published by many authors (Kawashima and Soares, 2003; Guerrero *et al*., 1998; Kruger *et al*.,1998; Ranhotra *et al*.,1998 and Becker, 1994).

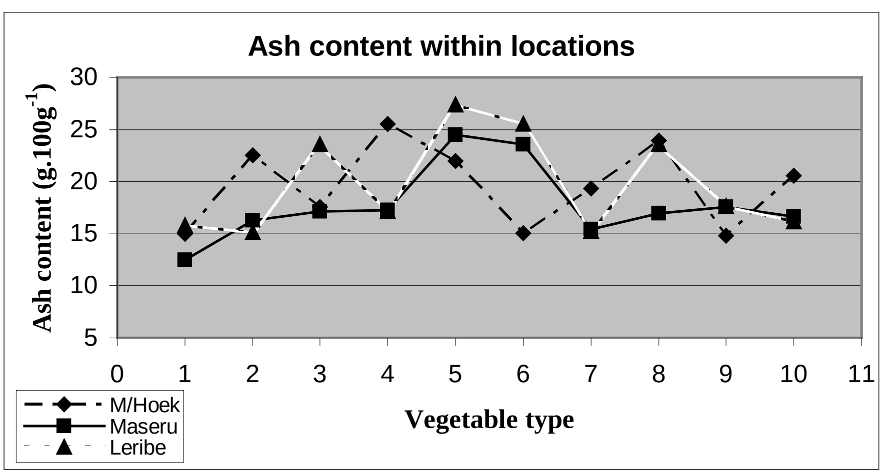

Figure 4.16 Ash content of vegetables across locations

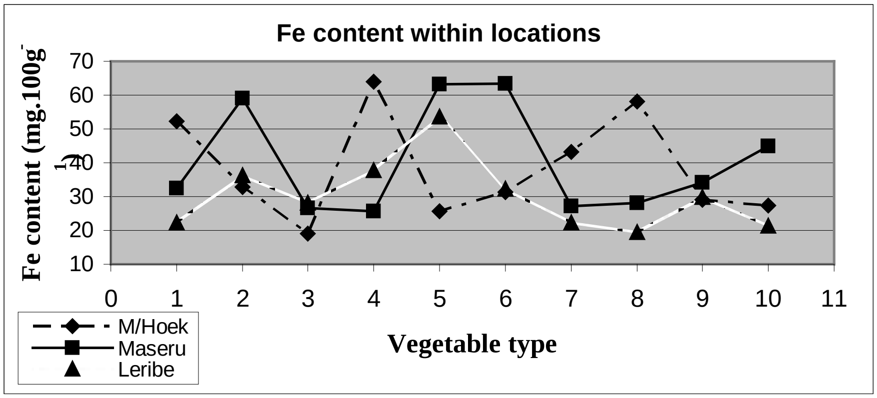

Figure 4.17 Iron (Fe) content of vegetables across locations

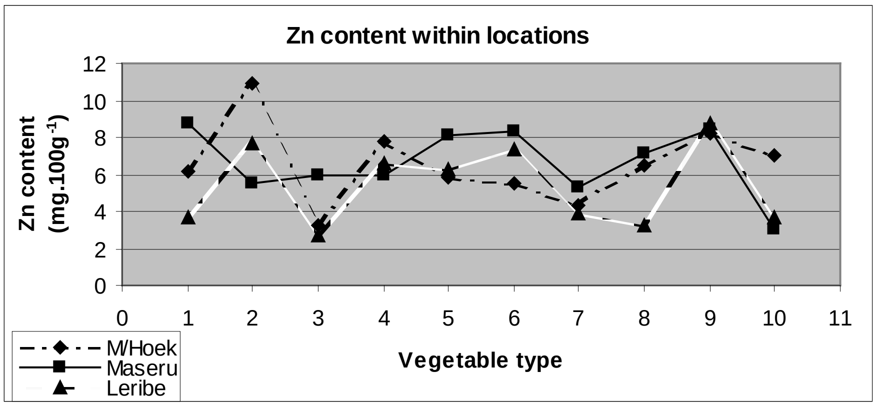

Figure 4.18 Zinc (Zn) content of vegetables across locations

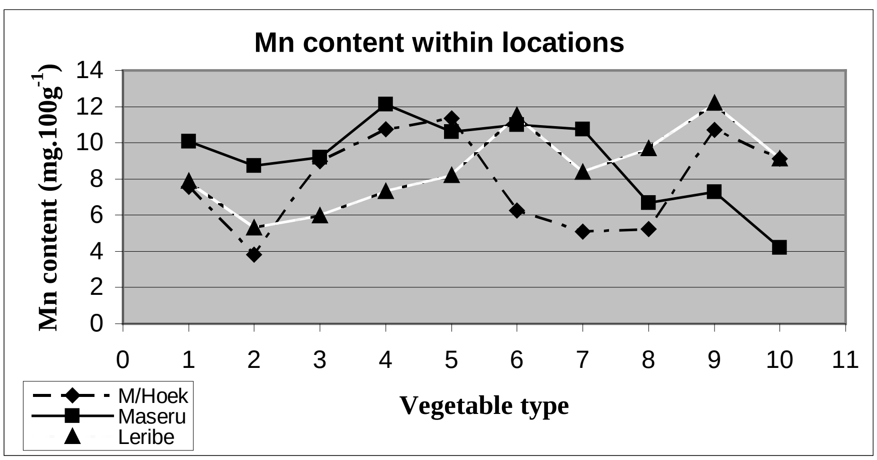

Figure 4.19 Manganese (Mn) content of vegetables across locations

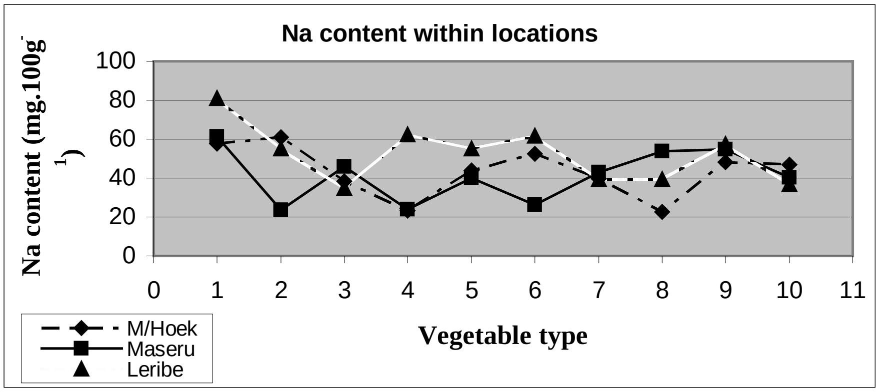

Figure 4.20 Sodium (Na) content of vegetables across locations

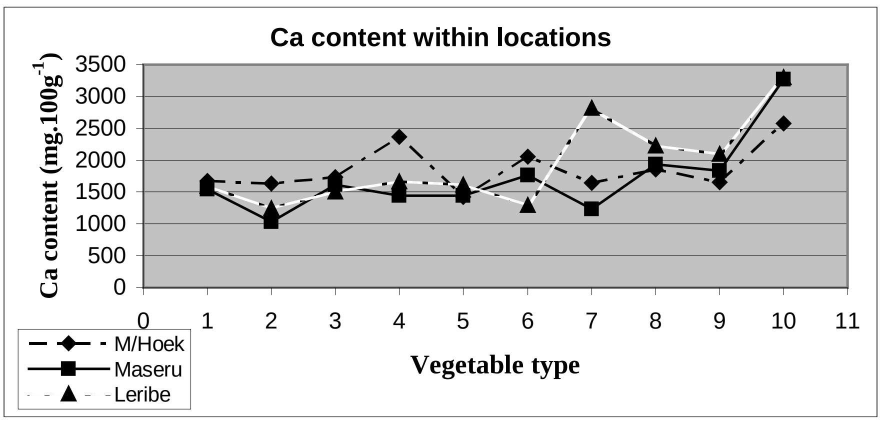

Figure 4.21 Calcium (Ca) content of vegetables across locations

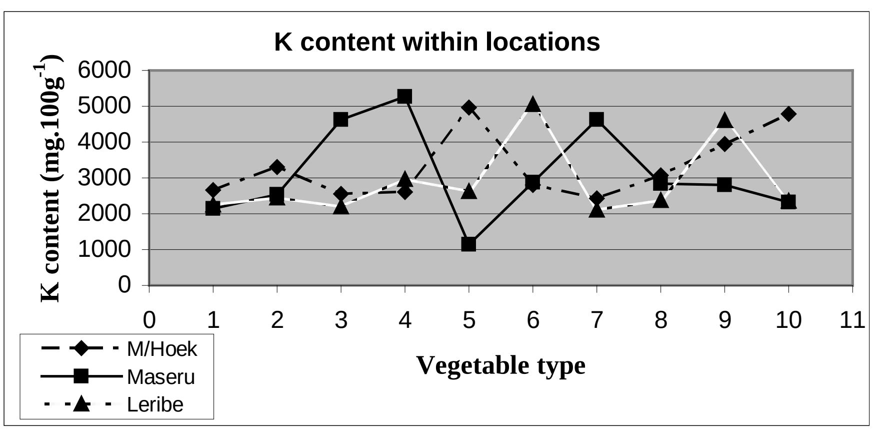

Figure 4.22 Potassium (K) content of vegetables across locations

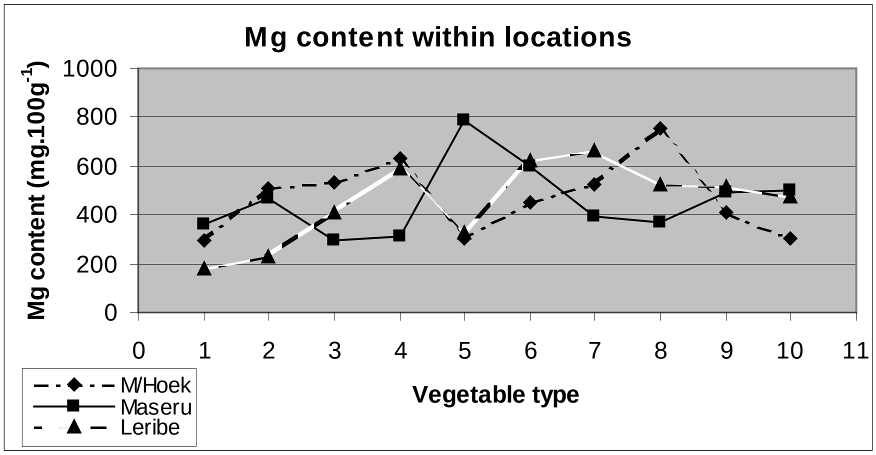

Figure 4.23 Magnesium (Mg) content of vegetables across locations

4.4 Conclusion

Ten indigenous vegetables were selected from the list of vegetables in Chapter 3. The maturity stage was taken into consideration and the plants were harvested at their optimum condition.

The overall nutritional quality of indigenous vegetables is good. It is evident from the results that most of the analysed vegetables had higher protein contents than spinach, and these include *Chenopodium album* (vegetable no. 2), *Sisymbrium capense* (no. 3), *Urtica dioca* (no. 4), *Amaranthus hybridus* (no. 8) and *Lipidium capense* (. 9). The best vegetables in terms of fat content are *Sonchus nanus* (no. 5), *Sonchus dre*geanus (no. 6) and *Wahlengergia androsacea* (no. 10). The best vegetables in terms of vitamin C levels are *Chenopodium album* (no. 2), *Sisymbrium capense* (no. 3), *Urtica dioca* (no. 4), *Rorippa nudiscula* (no. 7) and *Amaranthus hybridus* (no. 9). In the same manner β-carotene values were best reflected in *Urtica dioca* (no. 4) and *Rorippa nudiscula* (no. 7).

Plants do not perform equally well at all the locations, hence an interaction between vegetable type and location. Table 4.1 shows variation in the nutritional values of vegetable types. Taking for instance *Wahlengergia androsacea* (no. 10), the protein content for this plant is very low for all the locations, but its fat content is observed to be high in two locations (Maseru and Leribe) but very low in M/Hoek. The other nutrients also vary greatly in terms of this vegetable, without any direct relationship to location. Some plants perform exceptionally well at one location in terms of a certain nutrient, but later show an opposite trend in another nutrient for the same location. Nutritional value of plants is therefore dependent on location.

The second aim of this study was to determine the possible new cash crops. The nutritional information of *Chenopodium album* (no. 2), *Urtica dioca* (no. 4) and *Rorippa nudiscula* (no. 7) are very much promising for nomination into cash crops, taking into consideration the possible bioproductivity. *Rorippa nudiscula* (no. 7) is the best vegetable that can be recommended for development into a cash crop, but it is one of those flat single plants (Figure 4.7) and would possibly not produce the same biomass as *Amaranthus hybridus* (no. 8) (Figure 4.8) and *Chenopodium album* (no. 2) (Figure 4.2). The latter may therefore be better candidates, and their leaves may be harvested over a longer time (Tables 4.1 to 4.3). However, *Rorippa nudiscula* (no. 7) need not be counted out.

CHAPTER 5
GENERAL DISCUSSION AND CONCLUSIONS

Many green leafy indigenous vegetables are known in Lesotho (Guillarmod, 1982). Few of these are utilized as food, but their nutritional importance has never been researched. As a result they are neglected both by the consuming and scientific community. Prasad *et al.*, (1993) found that 90 indigenous food plants were known to be consumed and also indicated that the main reasons for decline in their consumption could be ascribed to the perceptions of the people, drought, modern farming systems, soil erosion and overgrazing, human settlement, over-harvesting, burning of veld and wild fire.

Little research has been done on the nutritional importance of indigenous vegetables. Vegetables fulfill multiple roles in the diet, not just as unique carriers of certain nutrients, but also adding flavor, color and texture that relieve the monotony of an otherwise bland starchy diet (Mnzava, 1997). Vegetables are naturally low in fat, good sources of fiber, and proved vitamins A and C, β-carotene, iron, potassium, calcium, folate and magnesium (Khan, 1998; Smith *et al*., 1996 and Willis *et al*., 1984). According to literature, Lesotho is faced with high degree of food insecurity and malnutrition, and Van den Heever (1997) also stated that the use of indigenous vegetables in regions with low agricultural potential due to factors such as drought, contribute to food security and provides dietary supplements to the staple diet. These reviews indicate that indigenous vegetables can be integrated into the human diet to improve nutritional status, at both household and national level. The aims of this study therefore were all addressed as mentioned in chapter 1, section 1.4.

Only older people (especially older women) use indigenous vegetables and they are also mostly used by the rural people. However only 5.3% of the participants were not using these plants. It is evident that knowledge is still available and thus can be revived through nutrition education. There were various reasons put forth for not using these food plants such as; they are not easy to collect as they are becoming scarce, they shrink when cooked, they are bitter to taste, they are associated with the rural poor community and exotic species are preferred to them. All these problems about the indigenous vegetable could only be addressed if their value is improved through assessing their nutritional attributes. In his study Quek, (1997) showed that knowing how indigenous knowledge is related to knowledge that experts have can assist us to understand indigenous knowledge better. This review tells us that if all the scientific knowledge about indigenous food plants is documented it would be very easy to give them the value they deserve. It was also evident from the study that young people had no interest about these food plants, as most of them refused to participate in this study. Those who participated mentioned few plants (less than 5) in their list of known plants. There were few plants that were used for food and medicinal purposes.

Most of the known vegetables were available in all the three districts. *Amaranthus hybridus, Chenopodium album, Lipidium capense, Sonchus nanus, Urtica dioca* and *Wahlengergia androsacea* were highly available (more than 50%). It should be noted that a higher percentage of vegetable availability was not related to consumption of vegetables. Correlation between location and the four attributes (knowledge, availability, consumption and preference) was very high ($P \leq 0.001$), with preference showing a higher contingency coefficient. This correlation degree tells us that many respondents were using indigenous vegetables in their diet in all the three districts. Correlation between location and preference also indicated that most of the participants in all the three districts preferred indigenous vegetables to exotic ones. There are those people who still like their indigenous vegetables and they use them in their daily food preparation. Different preparation methods of these vegetables were used, but the common one was combining two, even up to five indigenous vegetables (table 2.4) to enhance taste, or mask the taste of bitter vegetables and increase quantity. Exotic vegetables, spices, milk and pumpkin seeds (powdered) were also used to enhance taste.

Decline of the availability of indigenous vegetables was reported and it was a concern for most of the respondents. It was pointed out that food plants that were available in the past seemed to have also become extinct. Some Basotho people also attached stigma to the indigenous vegetables. Though some vegetables that were analyzed for nutritional content were not very popular in Basotho diet, it is believed that they can still be highly accepted by many Basotho if their nutritional value is well known.

A preliminary investigation on nutritional value showed that it seems as if the most frequent used plants also are of good nutritional value. This could not be taken as a fact, as it was observed that the vegetable materials were not of optimum harvest quality. Nevertheless, the results merited further investigation. When harvested at optimum harvest quality (Chapter 4) vegetables showed a relatively good nutritional value with *Amaranthus hybridus, Chenopodium album, Urtica dioca* and *Rorippa nudiscula* performing exceptionally well. *Amaranthus hybridus* and *sysimbrium thellungii* performed very well in all the nutrients. Ten selected indigenous vegetables showed a good nutritional value in all the three districts of Lesotho.

Location had a pronounced effect on the nutritional value of vegetables. Results in chapter 4 suggest that selected vegetables were excellent sources for protein and minerals, except manganese. There were magnificent differences in nutrient content between locations and vegetable types. *Amaranthus hybridus* was the most known and consumed vegetable in Chapter 2, and this means that it is one of the top vegetables in terms of popularity and nutritional value followed by *Rorippa nudiscula* and *Chenopodium album.*

Most Basotho people know about indigenous vegetables and use them in their diet. The nutritional value of these vegetables is comparably good (with spinach). It would therefore be substantial to conclude that indigenous vegetables used in this study can be recommended for use as food to address the problem of food insecurity and malnutrition, especially in the study areas (M/Hoek, Maseru and Leribe). The same crops, especially *Rorripa nudiscula, Chenpodium album* and *Amaranthus hybridus* can also be promoted as cash crops to address food shortages in the Southern region of Africa, as they can withstand harsh climates.

SUMMARY

A study was conducted on the usage and nutritional value of indigenous green leafy vegetables of Lesotho. Three rural areas were targeted in the districts of Mohales' Hoek, Maseru and Leribe, which respectively represent the geographical zones mountains/highlands, lowlands and foothills. Questionnaires were used to gather information from the indigenous knowledge of the Basotho people. It was found that the plants used as leafy green vegetables were well known, mainly by the older people, and that only 5.3% of the people under study never consume them. These represented the younger people and those that would or could not face the burden of collecting them. Of the people that do consume these, 22.6% use them daily. Different traditional and common recipes were used by the people for the preparation of the indigenous vegetables, usually as a stew. A single vegetable type, or up to five different ones, were used, either to complement volume or taste.

Preliminary studies on the nutritional value of the most frequently consumed vegetable types in the Maseru district showed high values, however, it was found that optimum harvest quality is of importance. Subsequently vegetables were harvested at all three the study sites and at the optimum harvest time for each. These plants were *Amaranthus hybridus*, *Chenopodium album*, *Lipidium capense*, *Nasturtium officinale*, *Rorippa nudiscula*, *Sisymbrium capense*, *Sonchus dregeanus*, *Sonchus nanus*, *Urtica dioca*, and *Wahlengergia androsacea*. An interaction was found between the vegetable type and location for all the nutrients analysed, which means that the nutritional value of all vegetables do not perform the same at the different locations. Vegetables that had an outstanding nutritional value regarding protein, lipid, vitamin C, β-carotene and mineral content are: *Chenopodium album*, *Urtica dioca*, *Sisymbrium capense*, *Amaranthus hybridus* and *Rorippa nudiscula*.

Considering the popularity of use, nutritional value and biomass production, *Chenopodium album* and *Amaranthus hybridus* would be good candidates for development as new cash crops. Although *Rorippa nudiscula* is a small flat plant and will lack in biomass production, its popularity and nutritional value would also merit its development as cash crop.

OPSOMMING

‘n Studie is uitgevoer op die gebruik en voedingswaarde van inheemse groen blaargroentes van Lesotho. Drie landelike gebiede is geïdentifiseer in die distrikte Mohale’s Hoek, Maseu en Leribe, wat onderskeidelik die berge/hooglande, laaglande en voetheuwels verteenwoordig. Vraelyste is gebruik om inligting te win van die inheemse kennis van die Basotho mense. Daar is bevind dat die plante wat as groen blaargroente gebruik word baie bekend is, veral onder die ouer mense, en dat slegs 5.3% van die mense onder studie nooit die plante inneem nie. Hierdie word verteenwoordig deur die jonger mense en diegene wat nie die las van versameling wil of kan opneem nie. Van die mense wat wel daarvan inneem, gebruik 22.6% dit daagliks. Verskillende tradisionele en algemene resepte word deur die mense gebruik in die voorbereiding van die inheemse groentes, gewoonlik as ‘n stowe. ‘n Enkele groentesoort, of soveel as vyf verskillendes, word gebruik, om volume of smaak aan te vul.

Voorlopige studies oor die voedingswaarde van die mees gebruikte groentesoorte in die Maseru distrik het hoë waardes getoon, maar dit is bevind dat die optimum oeskondisie van belang is. Gevolglik is die groentes ge-oes in al drie die studiegebiede en wel tydens die optimum oestyd vir elk. Hierdie plante was *Amaranthus hybridus*, *Chenopodium album*, *Lipidium capense*, *Nasturtium officinale*, *Rorippa nudiscula*, *Sisymbrium capense*, *Sonchus dregeanus*, *Sonchus nanus*, *Urtica dioca*, en *Wahlengergia androsacea*. ‘n Interaksie is waargeneem tussen die groentetipe an lokaliteit vir al die nutriente wat ge-analiseer is, wat beteken dat die voedingswaarde van al die groentesoorte nie ewe goed vaar in die verskillende lokaliteite nie. Groentesoorte wat ‘n uitstaande voedingswaarde getoon het betreffende proteïen, vet, vitamien C, β-karoteen en mineraalinhoud, is: *Chenopodium album, Urtica dioca*, *Sisymbrium capense*, *Amaranthus hybridus* en *Rorippa nudiscula*.

In aggenome die gewildheid van gebruik, voedingswaarde en biomassaproduksie, behoort *Chenopodium album* en *Amaranthus hybridus* goeie kandidate te wees om ontwikkel te word tot nuwe kontantgewasse. Alhoewel *Rorippa nudiscula* ‘n klein plat plant is en laag is in biomassaproduksie, bevestig sy gewildheid en voedingswaarde sy meriete om ook as kontantgewas ontwikkel te word.

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Appendix 1

QUESTIONNAIRE: INDIGENOUS PLANTS OF LESOTHO

UNIVERSITY OF FREE STATE

1. PERSONAL DETAILS

NAME:………………………………………………………………………….………………….

AGE:………..……………………………………………………………………………..………

AREA:…………………………………………………………………………………………

OCCUPATION:………..……………………..…………………………………………………

GENDER:……………………………………………………………………………………...…

LEVEL OF EDUCATION:……………………..…………………………………….....….

2. WHICH OF THE FOLLOWING VEGETATION PLANTS ARE FAMILIAR TO YOU?

3. WHICH OF THE FOLLOWING PLANTS ARE COMMONLY USED IN YOUR AREA?

4. WHICH OF THE FOLLOWING PLANTS DO YOU USE IN YOUR FOOD?

5. ARE THERE OTHER PEOPLE IN THE AREA ALSO USING THESE PLANTS:

…………………………………………………………………………………………………….

6. DO YOU USE THE PLANTS AS:

a. Food in itself: ……………………………………………………………….....

b. In combination of other food: **………………………………………………..**

c. Which food: ……………………………………………………………………….

7. HOW OFTEN DO YOU USE THEM?

Daily ☐

Weekly ☐

Twice a week ☐

Monthly ☐

Others ☐

8. WHY ?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

9. HOW DO YOU OBTAIN THESE PLANTS ?

Collect them in the field ☐

Buy from friends ☐

Buy from street vendors ☐

Get it free from friends ☐

Others ☐

10. AMONGST ALL THE PLANTS WHICH ONE'S ARE YOUR FAVOURITES?

11. GIVE ME AT LEAST TWO RECIPES THAT YOU OFTEN USE WHEN PREPARING THESE VEGETABLE DISHES

RECIPE 1	RECIPE 2
Ingredients:	Ingredients:
Method:	Method:

12. APART FROM USING THESE PLANTS AS FOOD OR RELISH, ARE THERE ANY OTHER PURPOSES THAT YOU USE THEM FOR?

1. ……………………………………………………………………………………………

2. ……………………………………………………………………………………………

3. ……………………………………………………………………………………………

13. IF USED AS MEDICATION, FOR WHICH ILLNESSES ARE THEY USED?

1. ……………………………………………………………………………………

2. ……………………………………………………………………………………

3. ……………………………………………………………………………………

14. DO YOU PREFER WILD OR CULTIVATED PLANTS, PROVIDED THE CONDITIONS OF COLLECTION, AVAILABILITY AND OTHER FACTORS WERE THE SAME?

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15. GENERAL COMMENTS

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Appendix 2

Critical Values of Chi Square

	Level of significance for a non-directional test					
df	.20	.10	.05	.02	.01	.001
1	1.6	2.71	3.84	5.41	6.64	10.83
2	3.22	4.60	5.99	7.82	9.21	13.82
3	4.64	6.25	7.82	9.84	11.34	16.27
4	5.99	7.78	9.49	11.67	13.28	18.46
5	7.29	9.24	11.07	13.39	15.09	20.52
6	8.56	10.64	12.59	15.03	16.81	22.46
7	9.80	12.02	14.07	16.62	18.48	24.32
8	11.03	13.36	15.51	18.17	20.09	26.12
9	12.24	14.68	16.92	19.68	21.67	27.88
10	13.44	15.99	18.31	21.16	23.21	29.59
11	14.63	17.28	19.68	22.62	24.72	31.26
12	15.81	18.55	21.03	24.05	26.22	32.91
13	16.98	19.81	22.36	25.47	27.69	34.53
14	18.15	21.06	23.68	26.87	29.14	36.12
15	19.31	22.31	25.00	28.26	30.58	37.70
16	20.46	23.54	26.30	29.63	32.00	39.29
17	21.62	24.77	27.59	31.00	33.41	40.75
18	22.76	25.99	28.87	32.35	34.80	42.31
19	23.90	27.20	30.14	33.69	36.19	43.82
20	25.04	28.41	31.41	35.02	37.57	45.32
21	26.17	29.62	32.67	36.34	38.93	46.80
22	27.30	30.81	33.92	37.66	40.29	48.27
23	28.43	32.01	35.17	38.97	41.64	49.73
24	29.55	33.20	36.42	40.27	42.98	51.18
25	30.68	34.38	37.65	41.57	44.31	52.62
26	31.80	35.56	38.88	42.86	45.64	54.05
27	32.91	36.74	40.11	44.14	46.96	55.48
28	34.03	37.92	41.34	45.42	48.28	56.89
29	35.14	39.09	42.69	46.69	49.59	58.30
30	36.25	40.26	43.77	47.96	50.89	59.70
32	38.47	42.59	46.19	50.49	53.49	62.49
34	40.68	44.90	48.60	53.00	56.06	65.25
36	42.88	47.21	51.00	55.49	58.62	67.99
38	45.08	49.51	53.38	57.97	61.16	70.70
40	47.27	51.81	55.76	60.44	63.69	73.40
44	51.64	56.37	60.48	65.34	68.71	78.75
48	55.99	60.91	65.17	70.20	73.68	84.04
52	60.33	65.42	69.83	75.02	78.62	89.27
56	64.66	69.92	74.47	79.82	83.51	94.46
60	68.97	74.40	79.08	84.58	88.38	99.61

Find the row corresponding to the indicated degrees of freedom, find the column corresponding to the chosen level of significance, the critical value of χ^2_{crit} is at the intersection of that row and that column. **If $\chi^2_{obs} \geq \chi^2_{crit}$ then H_o is rejected.**

Appendix 3

Protein

i/j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0252	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
2	0.0001	.	0.1284	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.1431	0.0001	0.4521	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9999	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
3	0.0001	0.1284	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.8197	0.0001	0.0644	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
4	0.0001	0.0001	0.0001	.	1	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0023	0.0001	0.0001	0.0001	0.0001	0.3721	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
5	0.0001	0.0001	0.0001	1	.	0.0001	0.0001	0.002	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.9213	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
6	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.1149	0.0001	0.0001	0.0001	0.2162	0.0001	0.0001	0.0001	0.0001	0.0001	0.0014	0.0001	0.0001	0.0001	0.1087
7	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.661	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
8	0.0001	0.0001	0.0001	0.0002	0.002	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.2872	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.6953	0.0001	0.0001
9	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001
10	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0081	0.0001	0.0001	0.0001	0.8588	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.661
11	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.661	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
12	0.0001	0.1431	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0066	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
13	0.0001	0.0001	0.0004	0.0023	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0016	0.9623	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
14	0.0001	0.4521	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9953	0.0001	0.0114	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
15	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.5379	0.0001	0.0001	0.0001	0.0001	0.0001
16	0.0001	0.0001	0.0001	0.0001	0.0001	0.1149	0.0001	0.0001	0.0001	0.0081	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9874	0.0001	0.0001	0.0001	0.0001
17	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0182	0.0001	0.0001
18	0.0001	0.0001	0.0001	0.3721	0.9213	0.0001	0.0001	0.2872	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.4521	0.0001	0.0001	0.0001	0.0001	0.0006	0.0001	0.0001
19	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001
20	0.0001	0.0001	0.0001	0.0001	0.0001	0.2162	0.0001	0.0001	0.0001	0.8588	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1
21	0.0252	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
22	0.0001	0.9999	0.8197	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0066	0.0001	0.9953	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
23	0.0001	0.0001	0.0001	1	1	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0016	0.0001	0.0001	0.0001	0.0001	0.4521	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
24	0.0001	0.0001	0.0644	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9623	0.0114	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
25	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.5379	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001
26	0.0001	0.0001	0.0001	0.0001	0.0001	0.0014	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9874	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001
27	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0018	0.0001	0.0001
28	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.6953	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0182	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0018	.	0.0001	0.0001
29	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001
30	0.0001	0.0001	0.0001	0.0001	0.0001	0.1087	0.0001	0.0001	0.0001	0.661	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.

Fat

1	.	0.0172	0.0001	0.9966	0.0001	0.0001	0.9994	0.9985	0.0104	1	0.0001	0.0001	0.004	0.0001	0.0001	0.0001	0.5012	0.0139	0.005	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0012	0.0001
2	0.0172	.	0.0001	0.4643	0.0001	0.0001	0.0004	0.0003	1	0.0213	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.9945	0.0001	1	0.0001	0.0053	0.0001	0.1777	0.0001	0.0001	0.0001	0.0593	0.0104	1	0.0001
3	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0006	0.0001	0.0001	0.0001
4	0.9966	0.4643	0.0001	.	0.0001	0.0001	0.3938	0.3447	0.3447	0.9985	0.0001	0.0001	0.1777	0.0001	0.0001	0.0001	0.9999	0.0002	0.2094	0.0001	0.9384	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9847	0.0676	0.0001
5	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.9995	1	0.0001	1	0.0001	0.0001	0.0001	0.1415	0.0001	0.0001	0.0001	0.998	0.0001	0.9998	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
6	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	1	0.0001	0.0001	0.0001	0.839	0.0001	0.0001	0.0001	0.0001	0.0001	0.2851	0.0001	0.0001	0.0001	0.7439
7	0.9994	0.0004	0.0001	0.3938	0.0001	0.0001	.	1	0.0002	0.9985	0.0019	0.0001	0.0001	0.0001	0.0001	0.0001	0.0302	0.314	0.0001	0.0001	1	0.0027	0.0001	0.0015	0.0001	0.0001	0.0001	1	0.0001	0.0001
8	0.9985	0.0003	0.0001	0.3447	0.0001	0.0001	1	.	0.0002	0.9966	0.0023	0.0001	0.0001	0.0001	0.0001	0.0001	0.0245	0.3607	0.0001	0.0001	1	0.0034	0.0001	0.0019	0.0001	0.0001	0.0001	0.9998	0.0001	0.0001
9	0.0104	1	0.0001	0.3447	0.0001	0.0001	0.0002	0.0002	.	0.0129	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.9782	0.0001	1	0.0001	0.0032	0.0001	0.258	0.0001	0.0001	0.0001	0.0928	0.0062	1	0.0001
10	1	0.0213	0.0001	0.9985	0.0001	0.0001	0.9985	0.9966	0.0129	.	0.0001	0.0001	0.005	0.0001	0.0001	0.0001	0.5579	0.0112	0.0062	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0015	0.0001
11	0.0001	0.0001	0.0001	0.0001	0.9995	0.0001	0.0019	0.0023	0.0001	0.0001	.	0.9743	0.0001	0.7777	0.0001	0.0001	0.0001	0.8902	0.0001	0.0001	0.0001	1	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
12	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.9743	.	0.0001	1	0.0001	0.0001	0.0001	0.0487	0.0001	0.0001	0.0001	0.946	0.0001	0.9847	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
13	0.004	1	0.0001	0.1777	0.0001	0.0001	0.0001	0.0001	1	0.005	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.8785	0.0001	1	0.0001	0.0012	0.0001	0.4643	0.0001	0.0001	0.0001	0.1984	0.0023	1	0.0001
14	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.7777	1	0.0001	.	0.0001	0.0001	0.0001	0.0129	0.0001	0.0001	0.0001	0.6903	0.0001	0.8246	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
15	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	1	0.0001	0.0001	0.0001	0.9874	0.0001	0.0001	0.0001	0.0001	0.0001	0.0987	0.0001	0.0001	0.0001	0.3938
16	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	.	0.0001	0.0001	0.0001	0.9698	0.0001	0.0001	0.0001	0.0001	0.0001	0.1334	0.0001	0.0001	0.0001	0.4827
17	0.5012	0.9945	0.0001	0.9999	0.0001	0.0001	0.0302	0.0245	0.9782	0.5579	0.0001	0.0001	0.8785	0.0001	0.0001	0.0001	.	0.0001	0.9116	0.0001	0.2452	0.0001	0.0034	0.0001	0.0001	0.0001	0.0009	0.3771	0.6152	0.0001
18	0.0139	0.0001	0.0001	0.0002	0.1415	0.0001	0.314	0.3607	0.0001	0.0112	0.8902	0.0487	0.0001	0.0129	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0426	0.9384	0.0001	0.8528	0.0001	0.0001	0.0001	0.0229	0.0001	0.0001
19	0.005	1	0.0001	0.2094	0.0001	0.0001	0.0001	0.0001	1	0.0062	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.9116	0.0001	.	0.0001	0.0015	0.0001	0.411	0.0001	0.0001	0.0001	0.168	0.0029	1	0.0001
20	0.0001	0.0001	0.0001	0.0001	0.0001	0.839	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9874	0.9698	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0012	0.0001	0.0001	0.0001	0.0083
21	1	0.0053	0.0001	0.9384	0.0001	0.0001	1	1	0.0032	1	0.0001	0.0001	0.0012	0.0001	0.0001	0.0001	0.2452	0.0426	0.0015	0.0001	.	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0003	0.0001
22	0.0001	0.0001	0.0001	0.0001	0.998	0.0001	0.0027	0.0034	0.0001	0.0001	1	0.946	0.0001	0.6903	0.0001	0.0001	0.0001	0.9384	0.0001	0.0001	0.0002	.	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
23	0.0001	0.1777	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.258	0.0001	0.0001	0.0001	0.4643	0.0001	0.0001	0.0001	0.0034	0.0001	0.411	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	1	0.0001	0.7611	0.0001
24	0.0001	0.0001	0.0001	0.0001	0.9998	0.0001	0.0015	0.0019	0.0001	0.0001	1	0.9847	0.0001	0.8246	0.0001	0.0001	0.0001	0.8528	0.0001	0.0001	0.0001	1	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
25	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0067	0.0001	0.0001	0.0001	0.0009
26	0.0001	0.0001	0.0001	0.0001	0.0001	0.2851	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0987	0.1334	0.0001	0.0001	0.0001	0.0012	0.0001	0.0001	0.0001	0.0001	0.0067	.	0.0001	0.0001	0.0001	1
27	0.0001	0.0593	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001	0.0928	0.0001	0.0001	0.0001	0.1984	0.0001	0.0001	0.0001	0.0009	0.0001	0.168	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	.	0.0001	0.4284	0.0001
28	1	0.0104	0.0001	0.9847	0.0001	0.0001	1	0.9998	0.0062	1	0.0001	0.0001	0.0023	0.0001	0.0001	0.0001	0.3771	0.0229	0.0029	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0007	0.0001
29	0.0012	1	0.0001	0.0676	0.0001	0.0001	0.0001	0.0001	1	0.0015	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.6152	0.0001	1	0.0001	0.0003	0.0001	0.7611	0.0001	0.0001	0.0001	0.4284	0.0007	.	0.0001
30	0.0001	0.0001	0.0001	0.0001	0.0001	0.7439	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.3938	0.4827	0.0001	0.0001	0.0001	0.0083	0.0001	0.0001	0.0001	0.0001	0.0009	1	0.0001	0.0001	0.0001	.

Fiber

1	.	0.0004	1	0.071	0.0002	0.8952	0.0156	0.4452	0.9991	1	0.0302	0.0001	0.413	0.0273	0.0001	0.0318	0.0139	0.0001	0.3728	0.0002	0.9161	0.0001	0.3292	0.7989	0.0001	0.0001	0.0015	0.0001	0.813	1
2	0.0004	.	0.0091	0.9413	1	0.0001	0.9995	0.3973	0.0174	0.0001	0.0001	0.9955	0.429	0.9953	0.0001	0.0001	0.9997	1	0.4717	1	0.0001	0.889	0.5227	0.1485	0.0001	0.0001	1	1	0.1408	0.0078

3	1	0.0091	.	0.5923	0.0053	0.2141	0.2291	0.9896	1	0.9773	0.0014	0.0001	0.9851	0.3376	0.0001	0.0014	0.2099	0.0025	0.9773	0.0054	0.238	0.0001	0.9649	1	0.0001	0.0001	0.0334	0.0004	1	1
4	0.071	0.9413	0.5923	.	0.8668	0.0003	1	1	0.7569	0.0145	0.0001	0.1198	1	1	0.0001	0.0001	1	0.7087	1	0.8691	0.0003	0.033	1	0.9982	0.0001	0.0001	0.9983	0.2686	0.9977	0.5539
5	0.0002	1	0.0053	0.8668	.	0.0001	0.9958	0.2836	0.0102	0.0001	0.0001	0.9994	0.3099	0.9794	0.0001	0.0001	0.9972	1	0.3462	1	0.0001	0.9542	0.3911	0.0958	0.0001	0.0001	1	1	0.0906	0.0045
6	0.8952	0.0001	0.2141	0.0003	0.0001	.	0.0001	0.0035	0.1292	0.9983	0.9262	0.0001	0.003	0.0001	0.0003	0.9325	0.0001	0.0001	0.0025	0.0001	1	0.0001	0.0021	0.0147	0.0001	0.0098	0.0001	0.0001	0.0156	0.238
7	0.0156	0.9995	0.2291	1	0.9958	0.0001	.	0.9964	0.355	0.0028	0.0001	0.3819	0.9977	1	0.0001	0.0001	1	0.9703	0.9988	0.996	0.0001	0.1364	0.9995	0.905	0.0001	0.0001	1	0.6513	0.8952	0.2059
8	0.4452	0.3973	0.9896	1	0.2836	0.0035	0.9964	.	0.9988	0.1393	0.0001	0.012	1	0.9996	0.0001	0.0001	0.9946	0.1666	1	0.2862	0.0041	0.0027	1	1	0.0001	0.0001	0.7348	0.0338	1	0.9846
9	0.9991	0.0174	1	0.7569	0.0102	0.1292	0.355	0.9988	.	0.9195	0.0007	0.0002	0.998	0.492	0.0001	0.0007	0.3292	0.0049	0.9964	0.0104	0.1454	0.0001	0.9931	1	0.0001	0.0001	0.0609	0.0007	1	1
10	1	0.0001	0.9773	0.0145	0.0001	0.9983	0.0028	0.1393	0.9195	.	0.1349	0.0001	0.1251	0.0051	0.0001	0.1408	0.0025	0.0001	0.1084	0.0001	0.999	0.0001	0.0916	0.3788	0.0001	0.0002	0.0003	0.0001	0.3942	0.9841
11	0.0302	0.0001	0.0014	0.0001	0.0001	0.9262	0.0001	0.0001	0.0007	0.1349	.	0.0001	0.0001	0.0001	0.067	1	0.0001	0.0001	0.0001	0.0001	0.9069	0.0001	0.0001	0.0001	0.02	0.6479	0.0001	0.0001	0.0001	0.0016
12	0.0001	0.9955	0.0001	0.1198	0.9994	0.0001	0.3819	0.012	0.0002	0.0001	0.0001	.	0.0137	0.2637	0.0001	0.0001	0.4098	1	0.0163	0.9993	0.0001	1	0.0198	0.0028	0.0001	0.0001	0.9069	1	0.0027	0.0001
13	0.413	0.429	0.9851	1	0.3099	0.003	0.9977	1	0.998	0.1251	0.0001	0.0137	.	0.9998	0.0001	0.0001	0.9965	0.1845	1	0.3126	0.0035	0.0031	1	1	0.0001	0.0001	0.7662	0.0383	1	0.9787
14	0.0273	0.9953	0.3376	1	0.9794	0.0001	1	0.9996	0.492	0.0051	0.0001	0.2637	0.9998	.	0.0001	0.0001	1	0.9143	0.9999	0.98	0.0001	0.0845	1	0.9658	0.0001	0.0001	1	0.5022	0.9608	0.3072
15	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001	0.0001	0.067	0.0001	0.0001	0.0001	.	0.0639	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001	1	0.9998	0.0001	0.0001	0.0001	0.0001
16	0.0318	0.0001	0.0014	0.0001	0.0001	0.9325	0.0001	0.0001	0.0007	0.1408	1	0.0001	0.0001	0.0001	0.0639	.	0.0001	0.0001	0.0001	0.0001	0.9143	0.0001	0.0001	0.0001	0.019	0.634	0.0001	0.0001	0.0001	0.0017
17	0.0139	0.9997	0.2099	1	0.9972	0.0001	1	0.9946	0.3292	0.0025	0.0001	0.4098	0.9965	1	0.0001	0.0001	.	0.9773	0.9981	0.9974	0.0001	0.1501	0.9991	0.8869	0.0001	0.0001	1	0.682	0.876	0.1882
18	0.0001	1	0.0025	0.7087	1	0.0001	0.9703	0.1666	0.0049	0.0001	0.0001	1	0.1845	0.9143	0.0001	0.0001	0.9773	.	0.2099	1	0.0001	0.992	0.2425	0.0502	0.0001	0.0001	1	1	0.0473	0.0021
19	0.3728	0.4717	0.9773	1	0.3462	0.0025	0.9988	1	0.9964	0.1084	0.0001	0.0163	1	0.9999	0.0001	0.0001	0.9981	0.2099	.	0.3491	0.003	0.0038	1	1	0.0001	0.0001	0.8046	0.045	1	0.9686
20	0.0002	1	0.0054	0.8691	1	0.0001	0.996	0.2862	0.0104	0.0001	0.0001	0.9993	0.3126	0.98	0.0001	0.0001	0.9974	1	0.3491	.	0.0001	0.953	0.3942	0.0969	0.0001	0.0001	1	1	0.0916	0.0046
21	0.9161	0.0001	0.238	0.0003	0.0001	1	0.0001	0.0041	0.1454	0.999	0.9069	0.0001	0.0035	0.0001	0.0003	0.9143	0.0001	0.0001	0.003	0.0001	.	0.0001	0.0024	0.0169	0.0001	0.0085	0.0001	0.0001	0.0181	0.2637
22	0.0001	0.889	0.0001	0.033	0.9542	0.0001	0.1364	0.0027	0.0001	0.0001	0.0001	1	0.0031	0.0845	0.0001	0.0001	0.1501	0.992	0.0038	0.953	0.0001	.	0.0046	0.0006	0.0001	0.0001	0.5888	1	0.0006	0.0001
23	0.3292	0.5227	0.9649	1	0.3911	0.0021	0.9995	1	0.9931	0.0916	0.0001	0.0198	1	1	0.0001	0.0001	0.9991	0.2425	1	0.3942	0.0024	0.0046	.	1	0.0001	0.0001	0.8449	0.054	1	0.953
24	0.7989	0.1485	1	0.9982	0.0958	0.0147	0.905	1	1	0.3788	0.0001	0.0028	1	0.9658	0.0001	0.0001	0.8869	0.0502	1	0.0969	0.0169	0.0006	1	.	0.0001	0.0001	0.3788	0.0085	1	0.9999
25	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.02	0.0001	0.0001	0.0001	1	0.019	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.983	0.0001	0.0001	0.0001	0.0001
26	0.0001	0.0001	0.0001	0.0001	0.0001	0.0098	0.0001	0.0001	0.0001	0.0002	0.6479	0.0001	0.0001	0.0001	0.9998	0.634	0.0001	0.0001	0.0001	0.0001	0.0085	0.0001	0.0001	0.0001	0.983	.	0.0001	0.0001	0.0001	0.0001
27	0.0015	1	0.0334	0.9983	1	0.0001	1	0.7348	0.0609	0.0003	0.0001	0.9069	0.7662	1	0.0001	0.0001	1	1	0.8046	1	0.0001	0.5888	0.8449	0.3788	0.0001	0.0001	.	0.9899	0.3638	0.0291
28	0.0001	1	0.0004	0.2686	1	0.0001	0.6513	0.0338	0.0007	0.0001	0.0001	1	0.0383	0.5022	0.0001	0.0001	0.682	1	0.045	1	0.0001	1	0.054	0.0085	0.0001	0.0001	0.9899	.	0.0079	0.0003
29	0.813	0.1408	1	0.9977	0.0906	0.0156	0.8952	1	1	0.3942	0.0001	0.0027	1	0.9608	0.0001	0.0001	0.876	0.0473	1	0.0916	0.0181	0.0006	1	1	0.0001	0.0001	0.3638	0.0079	.	1
30	1	0.0078	1	0.5539	0.0045	0.238	0.2059	0.9846	1	0.9841	0.0016	0.0001	0.9787	0.3072	0.0001	0.0017	0.1882	0.0021	0.9686	0.0046	0.2637	0.0001	0.953	0.9999	0.0001	0.0001	0.0291	0.0003	1	.

Ash

1	.	0.0001	0.3095	0.0001	0.0001	1	0.0017	0.0001	1	0.0001	0.3258	0.9962	0.6174	0.5097	0.0001	0.0001	1	0.7713	0.3225	0.949	1	1	0.0001	0.6216	0.0001	0.0001	1	0.0001	0.2523	0.9992
2	0.0001	.	0.0002	0.1055	1	0.0001	0.0653	0.9896	0.0001	0.7713	0.0001	0.0001	0.0001	0.0001	0.775	0.9999	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.9999	0.0001	0.0004	0.1041	0.0001	0.9999	0.0003	0.0001
3	0.3095	0.0002	.	0.0001	0.0013	0.3359	0.876	0.0001	0.189	0.1027	0.0001	0.9974	1	1	0.0001	0.0001	0.6174	1	1	1	0.9011	0.3962	0.0001	1	0.0001	0.0001	0.4854	0.0001	1	0.9901
4	0.0001	0.1055	0.0001	.	0.0212	0.0001	0.0001	0.9534	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.9999	0.7713	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.775	0.0001	0.8706	1	0.0001	0.775	0.0001	0.0001
5	0.0001	1	0.0013	0.0212	.	0.0001	0.2665	0.775	0.0001	0.9892	0.0001	0.0001	0.0003	0.0005	0.3393	0.9548	0.0001	0.0002	0.0012	0.0001	0.0001	0.0001	0.9534	0.0003	0.0001	0.0209	0.0001	0.9534	0.0018	0.0001

6	1	0.0001	0.3359	0.0001	0.0001	.	0.0019	0.0001	1	0.0001	0.2999	0.9976	0.6504	0.5426	0.0001	0.0001	1	0.7995	0.3496	0.9601	1	1	0.0001	0.6545	0.0001	0.0001	1	0.0001	0.2754	0.9996
7	0.0017	0.0653	0.876	0.0001	0.2665	0.0019	.	0.0008	0.0008	0.9984	0.0001	0.0923	0.5842	0.691	0.0001	0.0025	0.0062	0.4263	0.8651	0.2102	0.0225	0.0025	0.0025	0.58	0.0001	0.0001	0.0037	0.0025	0.9207	0.0634
8	0.0001	0.9896	0.0001	0.9534	0.775	0.0001	0.0008	.	0.0001	0.0388	0.0001	0.0001	0.0001	0.0001	1	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0334	0.9519	0.0001	1	0.0001	0.0001
9	1	0.0001	0.189	0.0001	0.0001	1	0.0008	0.0001	.	0.0001	0.4894	0.9743	0.4379	0.3427	0.0001	0.0001	1	0.5966	0.1982	0.8507	0.9999	1	0.0001	0.4418	0.0001	0.0001	1	0.0001	0.1497	0.9913
10	0.0001	0.7713	0.1027	0.0002	0.9892	0.0001	0.9984	0.0388	0.0001	.	0.0001	0.0021	0.0329	0.0483	0.0069	0.1055	0.0001	0.0181	0.0974	0.0062	0.0004	0.0001	0.1041	0.0324	0.0001	0.0002	0.0001	0.1041	0.1318	0.0014
11	0.3258	0.0001	0.0001	0.0001	0.0001	0.2999	0.0001	0.0001	0.4894	0.0001	.	0.0092	0.0005	0.0003	0.0001	0.0001	0.1284	0.001	0.0002	0.0032	0.0411	0.2495	0.0001	0.0005	0.0001	0.0001	0.1912	0.0001	0.0001	0.0141
12	0.9962	0.0001	0.9974	0.0001	0.0001	0.9976	0.0923	0.0001	0.9743	0.0021	0.0092	.	1	0.9999	0.0001	0.0001	1	1	0.998	1	1	0.9991	0.0001	1	0.0001	0.0001	0.9998	0.0001	0.9931	1
13	0.6174	0.0001	1	0.0001	0.0003	0.6504	0.5842	0.0001	0.4379	0.0329	0.0005	1	.	1	0.0001	0.0001	0.8963	1	1	1	0.9938	0.7186	0.0001	1	0.0001	0.0001	0.8029	0.0001	1	0.9999
14	0.5097	0.0001	1	0.0001	0.0005	0.5426	0.691	0.0001	0.3427	0.0483	0.0003	0.9999	1	.	0.0001	0.0001	0.8228	1	1	1	0.9808	0.6133	0.0001	1	0.0001	0.0001	0.7069	0.0001	1	0.9995
15	0.0001	0.775	0.0001	0.9999	0.3393	0.0001	0.0001	1	0.0001	0.0069	0.0001	0.0001	0.0001	0.0001	.	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.1554	0.9998	0.0001	1	0.0001	0.0001
16	0.0001	0.9999	0.0001	0.7713	0.9548	0.0001	0.0025	1	0.0001	0.1055	0.0001	0.0001	0.0001	0.0001	1	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0111	0.7677	0.0001	1	0.0001	0.0001
17	1	0.0001	0.6174	0.0001	0.0001	1	0.0062	0.0001	1	0.0001	0.1284	1	0.8963	0.8228	0.0001	0.0001	.	0.9649	0.634	0.9984	1	1	0.0001	0.8987	0.0001	0.0001	1	0.0001	0.5385	1
18	0.7713	0.0001	1	0.0001	0.0002	0.7995	0.4263	0.0001	0.5966	0.0181	0.001	1	1	1	0.0001	0.0001	0.9649	.	1	1	0.9993	0.8536	0.0001	1	0.0001	0.0001	0.9123	0.0001	1	1
19	0.3225	0.0002	1	0.0001	0.0012	0.3496	0.8651	0.0001	0.1982	0.0974	0.0002	0.998	1	1	0.0001	0.0001	0.634	1	.	1	0.9101	0.4111	0.0001	1	0.0001	0.0001	0.5016	0.0001	1	0.9917
20	0.949	0.0001	1	0.0001	0.0001	0.9601	0.2102	0.0001	0.8507	0.0062	0.0032	1	1	1	0.0001	0.0001	0.9984	1	1	.	1	0.9777	0.0001	1	0.0001	0.0001	0.9913	0.0001	0.9999	1
21	1	0.0001	0.9011	0.0001	0.0001	1	0.0225	0.0001	0.9999	0.0004	0.0411	1	0.9938	0.9808	0.0001	0.0001	1	0.9993	0.9101	1	.	1	0.0001	0.9941	0.0001	0.0001	1	0.0001	0.8507	1
22	1	0.0001	0.3962	0.0001	0.0001	1	0.0025	0.0001	1	0.0001	0.2495	0.9991	0.7186	0.6133	0.0001	0.0001	1	0.8536	0.4111	0.9777	1	.	0.0001	0.7225	0.0001	0.0001	1	0.0001	0.3291	0.9999
23	0.0001	0.9999	0.0001	0.775	0.9534	0.0001	0.0025	1	0.0001	0.1041	0.0001	0.0001	0.0001	0.0001	1	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0113	0.7713	0.0001	1	0.0001	0.0001
24	0.6216	0.0001	1	0.0001	0.0003	0.6545	0.58	0.0001	0.4418	0.0324	0.0005	1	1	1	0.0001	0.0001	0.8987	1	1	1	0.9941	0.7225	0.0001	.	0.0001	0.0001	0.8063	0.0001	1	0.9999
25	0.0001	0.0004	0.0001	0.8706	0.0001	0.0001	0.0001	0.0334	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.1554	0.0111	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0113	0.0001	.	0.8734	0.0001	0.0113	0.0001	0.0001
26	0.0001	0.1041	0.0001	1	0.0209	0.0001	0.0001	0.9519	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.9998	0.7677	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.7713	0.0001	0.8734	.	0.0001	0.7713	0.0001	0.0001
27	1	0.0001	0.4854	0.0001	0.0001	1	0.0037	0.0001	1	0.0001	0.1912	0.9998	0.8029	0.7069	0.0001	0.0001	1	0.9123	0.5016	0.9913	1	1	0.0001	0.8063	0.0001	0.0001	.	0.0001	0.4111	1
28	0.0001	0.9999	0.0001	0.775	0.9534	0.0001	0.0025	1	0.0001	0.1041	0.0001	0.0001	0.0001	0.0001	1	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0113	0.7713	0.0001	.	0.0001	0.0001
29	0.2523	0.0003	1	0.0001	0.0018	0.2754	0.9207	0.0001	0.1497	0.1318	0.0001	0.9931	1	1	0.0001	0.0001	0.5385	1	1	0.9999	0.8507	0.3291	0.0001	1	0.0001	0.0001	0.4111	0.0001	.	0.9785
30	0.9992	0.0001	0.9901	0.0001	0.0001	0.9996	0.0634	0.0001	0.9913	0.0014	0.0141	1	0.9999	0.9995	0.0001	0.0001	1	1	0.9917	1	1	0.9999	0.0001	0.9999	0.0001	0.0001	1	0.0001	0.9785	.

Vitamin C

1	.	1	0.8721	1	0.2822	0.0305	1	0.8756	1	0.9999	0.8953	0.8721	1	0.8873	0.0001	1	0.993	1	0.0234	0.6104	0.0834	0.8721	1	0.7126	1	1	0.2612	0.6688	0.4196	0.7872
2	1	.	0.879	1	0.2744	0.0293	1	0.8824	1	0.9999	0.8889	0.879	1	0.8937	0.0001	1	0.9938	1	0.0225	0.5997	0.0805	0.879	1	0.7024	1	1	0.2539	0.6583	0.4098	0.7781
3	0.8721	0.879	.	1	0.0014	0.0001	0.5594	1	0.2362	0.1813	0.0212	1	0.8857	1	0.0001	0.5328	1	0.8873	0.0001	0.0058	0.0003	1	0.2414	0.0088	0.8905	0.8937	0.0012	0.0074	0.0027	0.0121
4	1	1	1	.	0.0246	0.0016	0.9943	1	0.879	0.8115	0.2414	1	1	1	0.0001	0.9923	1	1	0.0012	0.0872	0.0052	1	0.884	0.1219	1	1	0.0221	0.1055	0.0447	0.1572
5	0.2822	0.2744	0.0014	0.0246	.	1	0.5997	0.0014	0.9116	0.9523	1	0.0014	0.2668	0.0015	0.2161	0.6264	0.006	0.265	1	1	1	0.0014	0.9073	1	0.2612	0.2575	1	1	1	1
6	0.0305	0.0293	0.0001	0.0016	1	.	0.102	0.0001	0.3042	0.3812	0.9274	0.0001	0.0282	0.0001	0.8283	0.1111	0.0004	0.0279	1	0.9969	1	0.0001	0.2981	0.9894	0.0274	0.0269	1	0.9936	0.9999	0.9765
7	1	1	0.5594	0.9943	0.5997	0.102	.	0.5648	1	1	0.9943	0.5594	1	0.5836	0.0003	1	0.884	1	0.0805	0.9029	0.2414	0.5594	1	0.9504	1	1	0.5702	0.9322	0.7593	0.9742
8	0.8756	0.8824	1	1	0.0014	0.0001	0.5648	.	0.2397	0.1842	0.0216	1	0.8889	1	0.0001	0.5381	1	0.8905	0.0001	0.006	0.0003	1	0.2449	0.009	0.8937	0.8968	0.0013	0.0075	0.0028	0.0123

9	1	1	0.2362	0.879	0.9116	0.3042	1	0.2397	.	1	1	0.2362	1	0.2521	0.0012	1	0.5514	1	0.2521	0.9966	0.5675	0.2362	1	0.9992	1	1	0.8953	0.9985	0.973	0.9998
10	0.9999	0.9999	0.1813	0.8115	0.9523	0.3812	1	0.1842	1	.	1	0.1813	0.9999	0.1944	0.0018	1	0.4597	0.9999	0.3209	0.9991	0.6609	0.1813	1	0.9999	0.9999	0.9999	0.9413	0.9997	0.9888	1
11	0.8953	0.8889	0.0212	0.2414	1	0.9274	0.9943	0.0216	1	1	.	0.0212	0.8824	0.0232	0.0212	0.9959	0.0784	0.8807	0.8889	1	0.9943	0.0212	1	1	0.8773	0.8738	1	1	1	1
12	0.8721	0.879	1	1	0.0014	0.0001	0.5594	1	0.2362	0.1813	0.0212	.	0.8857	1	0.0001	0.5328	1	0.8873	0.0001	0.0058	0.0003	1	0.2414	0.0088	0.8905	0.8937	0.0012	0.0074	0.0027	0.0121
13	1	1	0.8857	1	0.2668	0.0282	1	0.8889	1	0.9999	0.8824	0.8857	.	0.8999	0.0001	1	0.9945	1	0.0216	0.5889	0.0777	0.8857	1	0.6922	1	1	0.2467	0.6477	0.4002	0.7688
14	0.8873	0.8937	1	1	0.0015	0.0001	0.5836	1	0.2521	0.1944	0.0232	1	0.8999	.	0.0001	0.5568	1	0.9014	0.0001	0.0064	0.0003	1	0.2575	0.0096	0.9044	0.9073	0.0014	0.0081	0.003	0.0132
15	0.0001	0.0001	0.0001	0.0001	0.2161	0.8283	0.0003	0.0001	0.0012	0.0018	0.0212	0.0001	0.0001	0.0001	.	0.0003	0.0001	0.0001	0.879	0.0704	0.5594	0.0001	0.0012	0.0491	0.0001	0.0001	0.2345	0.0576	0.1325	0.0366
16	1	1	0.5328	0.9923	0.6264	0.1111	1	0.5381	1	1	0.9959	0.5328	1	0.5568	0.0003	.	0.8668	1	0.0879	0.9171	0.2594	0.5328	1	0.9593	1	1	0.597	0.9434	0.7827	0.9796
17	0.993	0.9938	1	1	0.006	0.0004	0.884	1	0.5514	0.4597	0.0784	1	0.9945	1	0.0001	0.8668	.	0.9947	0.0003	0.0239	0.0012	1	0.5594	0.0349	0.995	0.9953	0.0054	0.0296	0.0115	0.0469
18	1	1	0.8873	1	0.265	0.0279	1	0.8905	1	0.9999	0.8807	0.8873	1	0.9014	0.0001	1	0.9947	.	0.0214	0.5863	0.077	0.8873	1	0.6896	1	1	0.2449	0.6451	0.3978	0.7664
19	0.0234	0.0225	0.0001	0.0012	1	1	0.0805	0.0001	0.2521	0.3209	0.8889	0.0001	0.0216	0.0001	0.879	0.0879	0.0003	0.0214	.	0.9925	1	0.0001	0.2467	0.9786	0.021	0.0206	1	0.9861	0.9995	0.9576
20	0.6104	0.5997	0.0058	0.0872	1	0.9969	0.9029	0.006	0.9966	0.9991	1	0.0058	0.5889	0.0064	0.0704	0.9171	0.0239	0.5863	0.9925	.	1	0.0058	0.9962	1	0.5809	0.5755	1	1	1	1
21	0.0834	0.0805	0.0003	0.0052	1	1	0.2414	0.0003	0.5675	0.6609	0.9943	0.0003	0.0777	0.0003	0.5594	0.2594	0.0012	0.077	1	1	.	0.0003	0.5594	0.9998	0.0756	0.0743	1	0.9999	1	0.9993
22	0.8721	0.879	1	1	0.0014	0.0001	0.5594	1	0.2362	0.1813	0.0212	1	0.8857	1	0.0001	0.5328	1	0.8873	0.0001	0.0058	0.0003	.	0.2414	0.0088	0.8905	0.8937	0.0012	0.0074	0.0027	0.0121
23	1	1	0.2414	0.884	0.9073	0.2981	1	0.2449	1	1	1	0.2414	1	0.2575	0.0012	1	0.5594	1	0.2467	0.9962	0.5594	0.2414	.	0.9991	1	1	0.8905	0.9983	0.9711	0.9998
24	0.7126	0.7024	0.0088	0.1219	1	0.9894	0.9504	0.009	0.9992	0.9999	1	0.0088	0.6922	0.0096	0.0491	0.9593	0.0349	0.6896	0.9786	1	0.9998	0.0088	0.9991	.	0.6844	0.6792	1	1	1	1
25	1	1	0.8905	1	0.2612	0.0274	1	0.8937	1	0.9999	0.8773	0.8905	1	0.9044	0.0001	1	0.995	1	0.021	0.5809	0.0756	0.8905	1	0.6844	.	1	0.2414	0.6398	0.393	0.7617
26	1	1	0.8937	1	0.2575	0.0269	1	0.8968	1	0.9999	0.8738	0.8937	1	0.9073	0.0001	1	0.9953	1	0.0206	0.5755	0.0743	0.8937	1	0.6792	1	.	0.2379	0.6344	0.3883	0.7569
27	0.2612	0.2539	0.0012	0.0221	1	1	0.5702	0.0013	0.8953	0.9413	1	0.0012	0.2467	0.0014	0.2345	0.597	0.0054	0.2449	1	1	1	0.0012	0.8905	1	0.2414	0.2379	.	1	1	1
28	0.6688	0.6583	0.0074	0.1055	1	0.9936	0.9322	0.0075	0.9985	0.9997	1	0.0074	0.6477	0.0081	0.0576	0.9434	0.0296	0.6451	0.9861	1	0.9999	0.0074	0.9983	1	0.6398	0.6344	1	.	1	1
29	0.4196	0.4098	0.0027	0.0447	1	0.9999	0.7593	0.0028	0.973	0.9888	1	0.0027	0.4002	0.003	0.1325	0.7827	0.0115	0.3978	0.9995	1	1	0.0027	0.9711	1	0.393	0.3883	1	1	.	1
30	0.7872	0.7781	0.0121	0.1572	1	0.9765	0.9742	0.0123	0.9998	1	1	0.0121	0.7688	0.0132	0.0366	0.9796	0.0469	0.7664	0.9576	1	0.9993	0.0121	0.9998	1	0.7617	0.7569	1	1	1	.

Beta-carotene

1	.	0.0001	0.9997	0.0001	0.0003	0.1317	0.0001	0.0001	0.0001	0.4269	0.0891	0.0001	1	0.0001	0.0001	0.0108	0.0001	0.0001	0.0001	0.0965	0.0001	0.0001	1	0.0001	0.0009	1	0.0001	0.0001	0.4196	0.7872
2	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.005	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.4098	0.7781
3	0.9997	0.0001	.	0.0001	0.0001	0.005	0.0001	0.0001	0.0001	0.027	0.7594	0.0001	0.9961	0.0001	0.0001	0.0003	0.0001	0.0001	0.0006	0.0034	0.0055	0.0001	1	0.0001	0.0001	0.9993	0.0001	0.0001	0.0027	0.0121
4	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.6432	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.999	0.0001	0.0001	0.0055	0.0001	0.0447	0.1572
5	0.0003	0.0001	0.0001	0.0001	.	0.7594	0.0001	0.9908	0.0001	0.3411	0.0001	0.0001	0.0005	0.0001	1	0.9996	0.0001	0.0001	0.0001	0.8396	0.0001	0.0001	0.0001	0.0001	1	0.0003	0.0001	0.0001	1	1
6	0.1317	0.0001	0.005	0.0001	0.7594	.	0.0001	0.0385	0.0001	1	0.0001	0.0001	0.2183	0.0001	0.5453	1	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0171	0.0001	0.9483	0.153	0.0001	0.0001	0.9999	0.9765
7	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0031	0.0001	0.7593	0.9742
8	0.0001	0.0001	0.0001	0.0001	0.9908	0.0385	0.0001	.	0.0001	0.0074	0.0001	0.0001	0.0001	0.0001	0.9996	0.3411	0.0001	0.0001	0.0001	0.0543	0.0001	0.0001	0.0001	0.0001	0.9032	0.0001	0.0001	0.0001	0.0028	0.0123
9	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0352	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.9908	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.973	0.9998
10	0.4269	0.0001	0.027	0.0001	0.3411	1	0.0001	0.0074	0.0001	.	0.0001	0.0001	0.5943	0.0001	0.19	0.9908	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0822	0.0001	0.6188	0.4731	0.0001	0.0001	0.9888	1
11	0.0891	0.0001	0.7594	0.0001	0.0001	0.0001	0.0001	0.0001	0.0352	0.0001	.	0.0001	0.0498	0.0001	0.0001	0.0001	0.0001	0.0001	0.2496	0.0001	0.7373	0.0001	0.4498	0.0001	0.0001	0.0758	0.0001	0.0001	1	1

12	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9567	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0027	0.0121
13	1	0.0001	0.9961	0.0001	0.0005	0.2183	0.0001	0.0001	0.0001	0.5943	0.0498	0.0001	.	0.0001	0.0002	0.0206	0.0001	0.0001	0.0001	0.1646	0.0001	0.0001	1	0.0001	0.0017	1	0.0001	0.0001	0.4002	0.7688
14	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.003	0.0132
15	0.0001	0.0001	0.0001	0.0001	1	0.5453	0.0001	0.9996	0.0001	0.19	0.0001	0.0001	0.0002	0.0001	.	0.9908	0.0001	0.0001	0.0001	0.6432	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.1325	0.0366
16	0.0108	0.0001	0.0003	0.0001	0.9996	1	0.0001	0.3411	0.0001	0.9908	0.0001	0.0001	0.0206	0.0001	0.9908	.	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0011	0.0001	1	0.013	0.0001	0.0001	0.7827	0.9796
17	0.0001	0.0001	0.0001	0.6432	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.8396	0.0001	0.0115	0.0469
18	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0008	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.3978	0.7664
19	0.0001	0.0001	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.2496	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	1	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.9995	0.9576
20	0.0965	0.0001	0.0034	0.0001	0.8396	1	0.0001	0.0543	0.0001	1	0.0001	0.0001	0.1646	0.0001	0.6432	1	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0118	0.0001	0.9762	0.113	0.0001	0.0001	1	1
21	0.0001	0.0001	0.0055	0.0001	0.0001	0.0001	0.0001	0.0001	0.9908	0.0001	0.7373	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	.	0.0001	0.0016	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.9993
22	0.0001	0.005	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9567	0.0001	0.0001	0.0001	0.0001	0.0001	0.0008	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0143	0.0027	0.0121
23	1	0.0001	1	0.0001	0.0001	0.0171	0.0001	0.0001	0.0001	0.0822	0.4498	0.0001	1	0.0001	0.0001	0.0011	0.0001	0.0001	0.0002	0.0118	0.0016	0.0001	.	0.0001	0.0001	1	0.0001	0.0001	0.9711	0.9998
24	0.0001	0.0001	0.0001	0.999	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.1769	0.0001	1	1
25	0.0009	0.0001	0.0001	0.0001	1	0.9483	0.0001	0.9032	0.0001	0.6188	0.0001	0.0001	0.0017	0.0001	1	1	0.0001	0.0001	0.0001	0.9762	0.0001	0.0001	0.0001	0.0001	.	0.0011	0.0001	0.0001	0.393	0.7617
26	1	0.0001	0.9993	0.0001	0.0003	0.153	0.0001	0.0001	0.0001	0.4731	0.0758	0.0001	1	0.0001	0.0001	0.013	0.0001	0.0001	0.0001	0.113	0.0001	0.0001	1	0.0001	0.0011	.	0.0001	0.0001	0.3883	0.7569
27	0.0001	0.0001	0.0001	0.0055	0.0001	0.0001	0.0031	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.8396	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.1769	0.0001	0.0001	.	0.0001	1	1
28	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0143	0.0001	0.0001	0.0001	0.0001	0.0001	.	1	1
29	1	0.0001	1	0.0001	0.0001	0.0247	0.0001	0.0001	0.0001	0.113	0.3616	0.0001	1	0.0001	0.0001	0.0016	0.0001	0.0001	0.0001	0.0171	0.0011	0.0001	1	0.0001	0.0001	1	0.0001	0.0001	.	1
30	1	0.0001	1	0.0001	0.0001	0.0698	0.0001	0.0001	0.0001	0.2664	0.1646	0.0001	1	0.0001	0.0001	0.005	0.0001	0.0001	0.0001	0.0498	0.0003	0.0001	1	0.0001	0.0004	1	0.0001	0.0001	1	.

Iron

i/j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	.	0.0006	0.0001	0.1743	0.0001	0.0002	0.6392	0.9885	0.0001	0.0001	0.0005	0.9407	0.0001	0.0001	0.2662	0.2439	0.0001	0.0001	0.0017	0.907	0.0001	0.0096	0.0001	0.0284	1	0.0004	0.0001	0.0001	0.0001	0.0001
2	0.0006	.	0.0509	0.0001	0.9203	1	0.3444	0.0001	1	0.9951	1	0.0001	0.982	0.9198	0.0001	0.0001	0.9933	0.9996	1	0.139	0.3156	1	0.9995	0.9992	0.0002	1	0.3226	0.0612	1	0.211
3	0.0001	0.0509	.	0.0001	0.9635	0.1324	0.0001	0.0001	0.4344	0.7806	0.0625	0.0001	0.8733	0.9638	0.0001	0.0001	0.8031	0.6125	0.021	0.0001	1	0.0039	0.6323	0.0012	0.0001	0.0747	1	1	0.3195	1
4	0.1743	0.0001	0.0001	.	0.0001	0.0001	0.0002	0.99	0.0001	0.0001	0.0001	0.9992	0.0001	0.0001	1	1	0.0001	0.0001	0.0001	0.0009	0.0001	0.0001	0.0001	0.0001	0.3468	0.0001	0.0001	0.0001	0.0001	0.0001
5	0.0001	0.9203	0.9635	0.0001	.	0.9933	0.0027	0.0001	1	1	0.9461	0.0001	1	1	0.0001	0.0001	1	1	0.7447	0.0007	1	0.3322	1	0.1504	0.0001	0.9635	1	0.9766	1	0.9999
6	0.0002	1	0.1324	0.0001	0.9933	.	0.1568	0.0001	1	1	1	0.0001	0.9996	0.9932	0.0001	0.0001	0.9999	1	1	0.0538	0.5827	0.9992	1	0.9741	0.0001	1	0.5917	0.1559	1	0.4344
7	0.6392	0.3444	0.0001	0.0002	0.0027	0.1568	.	0.0225	0.0355	0.0093	0.2973	0.0108	0.0058	0.0027	0.0004	0.0004	0.0084	0.0182	0.5738	1	0.0002	0.9274	0.0169	0.9943	0.3902	0.2593	0.0002	0.0001	0.0566	0.0001
8	0.9885	0.0001	0.0001	0.99	0.0001	0.0001	0.0225	.	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.9985	0.9976	0.0001	0.0001	0.0001	0.0722	0.0001	0.0001	0.0001	0.0003	0.9997	0.0001	0.0001	0.0001	0.0001	0.0001
9	0.0001	1	0.4344	0.0001	1	1	0.0355	0.0001	.	1	1	0.0001	1	1	0.0001	0.0001	1	1	0.999	0.0104	0.9366	0.9179	1	0.6993	0.0001	1	0.9403	0.4854	1	0.8502
10	0.0001	0.9951	0.7806	0.0001	1	1	0.0093	0.0001	1	.	0.9977	0.0001	1	1	0.0001	0.0001	1	1	0.9505	0.0026	0.9983	0.6303	1	0.3551	0.0001	0.999	0.9985	0.8244	1	0.9889
11	0.0005	1	0.0625	0.0001	0.9461	1	0.2973	0.0001	1	0.9977	.	0.0001	0.9901	0.9457	0.0001	0.0001	0.9968	0.9999	1	0.1155	0.3644	1	0.9998	0.998	0.0002	1	0.372	0.0749	1	0.2486
12	0.9407	0.0001	0.0001	0.9992	0.0001	0.0001	0.0108	1	0.0001	0.0001	0.0001	.	0.0001	0.0001	1	0.9999	0.0001	0.0001	0.0001	0.0367	0.0001	0.0001	0.0001	0.0001	0.9942	0.0001	0.0001	0.0001	0.0001	0.0001
13	0.0001	0.982	0.8733	0.0001	1	0.9996	0.0058	0.0001	1	1	0.9901	0.0001	.	1	0.0001	0.0001	1	1	0.893	0.0016	0.9998	0.5087	1	0.2614	0.0001	0.9945	0.9998	0.9054	1	0.9974
14	0.0001	0.9198	0.9638	0.0001	1	0.9932	0.0027	0.0001	1	1	0.9457	0.0001	1	.	0.0001	0.0001	1	1	0.7438	0.0007	1	0.3314	1	0.1499	0.0001	0.9632	1	0.9768	1	0.9999
15	0.2662	0.0001	0.0001	1	0.0001	0.0001	0.0004	0.9985	0.0001	0.0001	0.0001	1	0.0001	0.0001	.	1	0.0001	0.0001	0.0001	0.0016	0.0001	0.0001	0.0001	0.0001	0.4844	0.0001	0.0001	0.0001	0.0001	0.0001
16	0.2439	0.0001	0.0001	1	0.0001	0.0001	0.0004	0.9976	0.0001	0.0001	0.0001	0.9999	0.0001	0.0001	1	.	0.0001	0.0001	0.0001	0.0014	0.0001	0.0001	0.0001	0.0001	0.4531	0.0001	0.0001	0.0001	0.0001	0.0001
17	0.0001	0.9933	0.8031	0.0001	1	0.9999	0.0084	0.0001	1	1	0.9968	0.0001	1	1	0.0001	0.0001	.	1	0.9403	0.0023	0.9988	0.6036	1	0.333	0.0001	0.9984	0.999	0.8445	1	0.9916
18	0.0001	0.9996	0.6125	0.0001	1	1	0.0182	0.0001	1	1	0.9999	0.0001	1	1	0.0001	0.0001	1	.	0.9895	0.0051	0.9856	0.7957	1	0.5194	0.0001	1	0.9868	0.6656	1	0.9483
19	0.0017	1	0.021	0.0001	0.7447	1	0.5738	0.0001	0.999	0.9505	1	0.0001	0.893	0.7438	0.0001	0.0001	0.9403	0.9895	.	0.2789	0.1611	1	0.9872	1	0.0006	1	0.1654	0.0256	0.9999	0.1005
20	0.907	0.139	0.0001	0.0009	0.0007	0.0538	1	0.0722	0.0104	0.0026	0.1155	0.0367	0.0016	0.0007	0.0016	0.0014	0.0023	0.0051	0.2789	.	0.0001	0.6792	0.0048	0.907	0.7097	0.0976	0.0001	0.0001	0.0172	0.0001
21	0.0001	0.3156	1	0.0001	1	0.5827	0.0002	0.0001	0.9366	0.9983	0.3644	0.0001	0.9998	1	0.0001	0.0001	0.9988	0.9856	0.1611	0.0001	.	0.0382	0.9882	0.0132	0.0001	0.4107	1	1	0.8634	1
22	0.0096	1	0.0039	0.0001	0.3322	0.9992	0.9274	0.0001	0.9179	0.6303	1	0.0001	0.5087	0.3314	0.0001	0.0001	0.6036	0.7957	1	0.6792	0.0382	.	0.7789	1	0.0035	1	0.0394	0.0049	0.9679	0.022
23	0.0001	0.9995	0.6323	0.0001	1	1	0.0169	0.0001	1	1	0.9998	0.0001	1	1	0.0001	0.0001	1	1	0.9872	0.0048	0.9882	0.7789	.	0.4999	0.0001	0.9999	0.9892	0.685	1	0.9553
24	0.0284	0.9992	0.0012	0.0001	0.1504	0.9741	0.9943	0.0003	0.6993	0.3551	0.998	0.0001	0.2614	0.1499	0.0001	0.0001	0.333	0.5194	1	0.907	0.0132	1	0.4999	.	0.0109	0.9959	0.0136	0.0015	0.8166	0.0073
25	1	0.0002	0.0001	0.3468	0.0001	0.0001	0.3902	0.9997	0.0001	0.0001	0.0002	0.9942	0.0001	0.0001	0.4844	0.4531	0.0001	0.0001	0.0006	0.7097	0.0001	0.0035	0.0001	0.0109	.	0.0001	0.0001	0.0001	0.0001	0.0001
26	0.0004	1	0.0747	0.0001	0.9635	1	0.2593	0.0001	1	0.999	1	0.0001	0.9945	0.9632	0.0001	0.0001	0.9984	1	1	0.0976	0.4107	1	0.9999	0.9959	0.0001	.	0.4188	0.0892	1	0.2854
27	0.0001	0.3226	1	0.0001	1	0.5917	0.0002	0.0001	0.9403	0.9985	0.372	0.0001	0.9998	1	0.0001	0.0001	0.999	0.9868	0.1654	0.0001	1	0.0394	0.9892	0.0136	0.0001	0.4188	.	1	0.8694	1
28	0.0001	0.0612	1	0.0001	0.9766	0.1559	0.0001	0.0001	0.4854	0.8244	0.0749	0.0001	0.9054	0.9768	0.0001	0.0001	0.8445	0.6656	0.0256	0.0001	1	0.0049	0.685	0.0015	0.0001	0.0892	1	.	0.3635	1
29	0.0001	1	0.3195	0.0001	1	1	0.0566	0.0001	1	1	1	0.0001	1	1	0.0001	0.0001	1	1	0.9999	0.0172	0.8634	0.9679	1	0.8166	0.0001	1	0.8694	0.3635	.	0.7411
30	0.0001	0.211	1	0.0001	0.9999	0.4344	0.0001	0.0001	0.8502	0.9889	0.2486	0.0001	0.9974	0.9999	0.0001	0.0001	0.9916	0.9483	0.1005	0.0001	1	0.022	0.9553	0.0073	0.0001	0.2854	1	1	0.7411	.

Zinc

1	.	0.4192	0.9819	1	1	1	1	1	0.9999	1	0.9963	1	1	1	1	0.9998	1	1	0.9995	0.9631	0.9979	1	0.9031	1	1	1	0.9996	0.9819	0.9957	0.9982

2	0.4192	.	0.008	0.9533	0.3162	0.2102	0.0432	0.56	0.9921	0.7724	0.9996	0.2114	0.3244	0.3568	0.9874	0.9946	0.1563	0.7988	0.997	0.0058	0.0164	0.9321	0.0033	0.6058	0.456	0.8632	0.0244	0.008	0.9997	0.0171
3	0.9819	0.008	.	0.5289	0.995	0.9995	1	0.9417	0.3481	0.8073	0.1958	0.9994	0.9943	0.9911	0.3855	0.3211	0.9999	0.7813	0.2846	1	1	0.5829	1	0.9215	0.9742	0.7039	1	1	0.1889	1
4	1	0.9533	0.5289	.	1	0.9995	0.9131	1	1	1	1	0.9996	1	1	1	1	0.9978	1	1	0.4482	0.7138	1	0.3227	1	1	1	0.8073	0.5289	1	0.7235
5	1	0.3162	0.995	1	.	1	1	1	0.9991	1	0.9858	1	1	1	0.9996	0.9985	1	1	0.997	0.9874	0.9997	1	0.956	1	1	1	1	0.995	0.9839	0.9997
6	1	0.2102	0.9995	0.9995	1	.	1	1	0.9928	1	0.9481	1	1	1	0.9957	0.9896	1	1	0.9833	0.998	1	0.9998	0.9887	1	1	1	1	0.9995	0.9433	1
7	1	0.0432	1	0.9131	1	1	.	0.9997	0.776	0.9925	0.5662	1	1	1	0.8124	0.7465	1	0.9894	0.7019	1	1	0.9383	1	0.9993	1	0.976	1	1	0.5537	1
8	1	0.56	0.9417	1	1	1	0.9997	.	1	1	0.9996	1	1	1	1	1	1	1	1	0.9019	0.9879	1	0.8023	1	1	1	0.9964	0.9417	0.9995	0.9892
9	0.9999	0.9921	0.3481	1	0.9991	0.9928	0.776	1	.	1	1	0.993	0.9992	0.9996	1	1	0.9797	1	1	0.283	0.5207	1	0.1912	1	1	1	0.6266	0.3481	1	0.531
10	1	0.7724	0.8073	1	1	1	0.9925	1	1	.	1	1	1	1	1	1	1	1	1	0.7351	0.9274	1	0.5954	1	1	1	0.966	0.8073	1	0.9321
11	0.9963	0.9996	0.1958	1	0.9858	0.9481	0.5662	0.9996	1	1	.	0.9488	0.9872	0.9915	1	1	0.9007	1	1	0.1534	0.3227	1	0.0979	0.9998	0.9978	1	0.4135	0.1958	1	0.3311
12	1	0.2114	0.9994	0.9996	1	1	1	1	0.993	1	0.9488	.	1	1	0.9958	0.9899	1	1	0.9836	0.998	1	0.9998	0.9885	1	1	1	1	0.9994	0.9442	1
13	1	0.3244	0.9943	1	1	1	1	1	0.9992	1	0.9872	1	.	1	0.9996	0.9987	1	1	0.9974	0.986	0.9996	1	0.9525	1	1	1	1	0.9943	0.9855	0.9997
14	1	0.3568	0.9911	1	1	1	1	1	0.9996	1	0.9915	1	1	.	0.9998	0.9993	1	1	0.9985	0.9797	0.9993	1	0.9375	1	1	1	0.9999	0.9911	0.9903	0.9994
15	1	0.9874	0.3855	1	0.9996	0.9957	0.8124	1	1	1	1	0.9958	0.9996	0.9998	.	1	0.9866	1	1	0.3162	0.5641	1	0.2164	1	1	1	0.6698	0.3855	1	0.5745
16	0.9998	0.9946	0.3211	1	0.9985	0.9896	0.7465	1	1	1	1	0.9899	0.9987	0.9993	1	.	0.9728	1	1	0.2594	0.488	1	0.1736	1	0.9999	1	0.5933	0.3211	1	0.4982
17	1	0.1563	0.9999	0.9978	1	1	1	1	0.9797	1	0.9007	1	1	1	0.9866	0.9728	.	1	0.96	0.9996	1	0.999	0.9965	1	1	0.9999	1	0.9999	0.8936	1
18	1	0.7988	0.7813	1	1	1	0.9894	1	1	1	1	1	1	1	1	1	1	.	1	0.7059	0.912	1	0.5641	1	1	1	0.9567	0.7813	1	0.9174
19	0.9995	0.997	0.2846	1	0.997	0.9833	0.7019	1	1	1	1	0.9836	0.9974	0.9985	1	1	0.96	1	.	0.2279	0.4423	1	0.1505	1	0.9998	1	0.5454	0.2846	1	0.4521
20	0.9631	0.0058	1	0.4482	0.9874	0.998	1	0.9019	0.283	0.7351	0.1534	0.998	0.986	0.9797	0.3162	0.2594	0.9996	0.7059	0.2279	.	1	0.5002	1	0.8743	0.9503	0.6224	1	1	0.1477	1
21	0.9979	0.0164	1	0.7138	0.9997	1	1	0.9879	0.5207	0.9274	0.3227	1	0.9996	0.9993	0.5641	0.488	1	0.912	0.4423	1	.	0.7632	1	0.9812	0.9964	0.8604	1	1	0.3129	1
22	1	0.9321	0.5829	1	1	0.9998	0.9383	1	1	1	1	0.9998	1	1	1	1	0.999	1	1	0.5002	0.7632	.	0.3675	1	1	1	0.8487	0.5829	1	0.7724
23	0.9031	0.0033	1	0.3227	0.956	0.9887	1	0.8023	0.1912	0.5954	0.0979	0.9885	0.9525	0.9375	0.2164	0.1736	0.9965	0.5641	0.1505	1	1	0.3675	.	0.7632	0.8796	0.48	1	1	0.094	1
24	1	0.6058	0.9215	1	1	1	0.9993	1	1	1	0.9998	1	1	1	1	1	1	1	1	0.8743	0.9812	1	0.7632	.	1	1	0.9938	0.9215	0.9998	0.9829
25	1	0.456	0.9742	1	1	1	1	1	1	1	0.9978	1	1	1	1	0.9999	1	1	0.9998	0.9503	0.9964	1	0.8796	1	.	1	0.9992	0.9742	0.9974	0.9969
26	1	0.8632	0.7039	1	1	1	0.976	1	1	1	1	1	1	1	1	1	0.9999	1	1	0.6224	0.8604	1	0.48	1	1	.	0.9225	0.7039	1	0.8674
27	0.9996	0.0244	1	0.8073	1	1	1	0.9964	0.6266	0.966	0.4135	1	1	0.9999	0.6698	0.5933	1	0.9567	0.5454	1	1	0.8487	1	0.9938	0.9992	0.9225	.	1	0.4022	1
28	0.9819	0.008	1	0.5289	0.995	0.9995	1	0.9417	0.3481	0.8073	0.1958	0.9994	0.9943	0.9911	0.3855	0.3211	0.9999	0.7813	0.2846	1	1	0.5829	1	0.9215	0.9742	0.7039	1	.	0.1889	1
29	0.9957	0.9997	0.1889	1	0.9839	0.9433	0.5537	0.9995	1	1	1	0.9442	0.9855	0.9903	1	1	0.8936	1	1	0.1477	0.3129	1	0.094	0.9998	0.9974	1	0.4022	0.1889	.	0.3211
30	0.9982	0.0171	1	0.7235	0.9997	1	1	0.9892	0.531	0.9321	0.3311	1	0.9997	0.9994	0.5745	0.4982	1	0.9174	0.4521	1	1	0.7724	1	0.9829	0.9969	0.8674	1	1	0.3211	.

Manganese

1	.	0.0495	0.9982	0.1893	0.0458	0.9995	0.6219	0.7242	0.2035	0.9929	0.5747	0.9999	0.9882	0.0054	0.2439	0.109	0.1893	1	1	0.1236	1	0.7733	0.9909	1	1	0.0295	1	0.8432	0.0045	0.9923
2	0.0495	.	0.001	0.0001	0.0001	0.6219	0.9995	0.9976	0.0001	0.0006	0.0001	0.002	0.0005	0.0001	0.0001	0.0001	0.0001	0.3348	0.0993	1	0.0217	0.9952	0.8184	0.0914	0.0093	0.0001	0.0055	0.0001	0.0001	0.0006
3	0.9982	0.001	.	0.9679	0.6827	0.4536	0.0368	0.0534	0.9741	1	1	1	1	0.1953	0.9858	0.8914	0.9679	0.7508	0.9806	0.003	1	0.0644	0.2738	0.9847	1	0.5602	1	1	0.1703	1
4	0.1893	0.0001	0.9679	.	1	0.0072	0.0002	0.0004	1	0.9882	1	0.8978	0.9929	0.9985	1	1	1	0.0229	0.1005	0.0001	0.3468	0.0005	0.0031	0.109	0.5566	1	0.6898	1	0.9971	0.989

5	0.0458	0.0001	0.6827	1	.	0.0013	0.0001	0.0001	1	0.7827	0.9997	0.5133	0.8213	1	1	1	1	0.0043	0.0217	0.0001	0.0993	0.0001	0.0005	0.0238	0.1973	1	0.2843	0.9842	1	0.7888
6	0.9995	0.6219	0.4536	0.0072	0.0013	.	0.9999	1	0.0079	0.3559	0.0419	0.6219	0.3174	0.0001	0.0102	0.0035	0.0072	1	1	0.8637	0.9894	1	1	1	0.9311	0.0008	0.8537	0.1128	0.0001	0.3498
7	0.6219	0.9995	0.0368	0.0002	0.0001	0.9999	.	1	0.0003	0.0248	0.0016	0.0668	0.0208	0.0001	0.0003	0.0001	0.0002	0.9906	0.8127	1	0.4	1	1	0.7919	0.2276	0.0001	0.1545	0.0052	0.0001	0.0242
8	0.7242	0.9976	0.0534	0.0004	0.0001	1	1	.	0.0004	0.0364	0.0025	0.0947	0.0307	0.0001	0.0005	0.0002	0.0004	0.9973	0.8871	1	0.4991	1	1	0.871	0.3006	0.0001	0.2099	0.0078	0.0001	0.0354
9	0.2035	0.0001	0.9741	1	1	0.0079	0.0003	0.0004	.	0.9909	1	0.9117	0.9947	0.9978	1	1	1	0.0251	0.109	0.0001	0.3682	0.0005	0.0034	0.1181	0.582	1	0.714	1	0.9959	0.9916
10	0.9929	0.0006	1	0.9882	0.7827	0.3559	0.0248	0.0364	0.9909	.	1	1	1	0.2636	0.9958	0.9446	0.9882	0.6472	0.9526	0.0019	0.9998	0.0441	0.2035	0.9608	1	0.6686	1	1	0.2321	1
11	0.5747	0.0001	1	1	0.9997	0.0419	0.0016	0.0025	1	1	.	0.999	1	0.8826	1	1	1	0.1168	0.3776	0.0001	0.7919	0.0031	0.0192	0.4	0.9358	0.9978	0.9771	1	0.8511	1
12	0.9999	0.002	1	0.8978	0.5133	0.6219	0.0668	0.0947	0.9117	1	0.999	.	1	0.1168	0.9418	0.7638	0.8978	0.8826	0.9971	0.0058	1	0.1128	0.4132	0.9979	1	0.3968	1	1	0.1005	1
13	0.9882	0.0005	1	0.9929	0.8213	0.3174	0.0208	0.0307	0.9947	1	1	1	.	0.2978	0.9977	0.9608	0.9929	0.6002	0.9343	0.0016	0.9994	0.0373	0.1777	0.9446	1	0.714	1	1	0.2636	1
14	0.0054	0.0001	0.1953	0.9985	1	0.0001	0.0001	0.0001	0.9978	0.2636	0.8826	0.1168	0.2978	.	0.9949	0.9999	0.9985	0.0004	0.0024	0.0001	0.0131	0.0001	0.0001	0.0027	0.0303	1	0.0489	0.6328	1	0.2687
15	0.2439	0.0001	0.9858	1	1	0.0102	0.0003	0.0005	1	0.9958	1	0.9418	0.9977	0.9949	.	1	1	0.0319	0.1338	0.0001	0.4265	0.0007	0.0044	0.1446	0.6472	1	0.7733	1	0.9913	0.9961
16	0.109	0.0001	0.8914	1	1	0.0035	0.0001	0.0002	1	0.9446	1	0.7638	0.9608	0.9999	1	.	1	0.0116	0.0547	0.0001	0.2164	0.0002	0.0015	0.0597	0.384	1	0.5097	0.9994	0.9998	0.9474
17	0.1893	0.0001	0.9679	1	1	0.0072	0.0002	0.0004	1	0.9882	1	0.8978	0.9929	0.9985	1	1	.	0.0229	0.1005	0.0001	0.3468	0.0005	0.0031	0.109	0.5566	1	0.6898	1	0.9971	0.989
18	1	0.3348	0.7508	0.0229	0.0043	1	0.9906	0.9973	0.0251	0.6472	0.1168	0.8826	0.6002	0.0004	0.0319	0.0116	0.0229	.	1	0.5929	0.9999	0.9988	1	1	0.9958	0.0026	0.9819	0.2738	0.0004	0.64
19	1	0.0993	0.9806	0.1005	0.0217	1	0.8127	0.8871	0.109	0.9526	0.3776	0.9971	0.9343	0.0024	0.1338	0.0547	0.1005	1	.	0.2276	1	0.9173	0.9995	1	1	0.0137	1	0.6615	0.002	0.95
20	0.1236	1	0.003	0.0001	0.0001	0.8637	1	1	0.0001	0.0019	0.0001	0.0058	0.0016	0.0001	0.0001	0.0001	0.0001	0.5929	0.2276	.	0.0583	1	0.965	0.212	0.0262	0.0001	0.0159	0.0004	0.0001	0.0019
21	1	0.0217	1	0.3468	0.0993	0.9894	0.4	0.4991	0.3682	0.9998	0.7919	1	0.9994	0.0131	0.4265	0.2164	0.3468	0.9999	1	0.0583	.	0.5529	0.9358	1	1	0.066	1	0.9608	0.011	0.9997
22	0.7733	0.9952	0.0644	0.0005	0.0001	1	1	1	0.0005	0.0441	0.0031	0.1128	0.0373	0.0001	0.0007	0.0002	0.0005	0.9988	0.9173	1	0.5529	.	1	0.9039	0.3438	0.0001	0.2439	0.0097	0.0001	0.043
23	0.9909	0.8184	0.2738	0.0031	0.0005	1	1	1	0.0034	0.2035	0.0192	0.4132	0.1777	0.0001	0.0044	0.0015	0.0031	1	0.9995	0.965	0.9358	1	.	0.9992	0.7919	0.0003	0.6686	0.0554	0.0001	0.1994
24	1	0.0914	0.9847	0.109	0.0238	1	0.7919	0.871	0.1181	0.9608	0.4	0.9979	0.9446	0.0027	0.1446	0.0597	0.109	1	1	0.212	1	0.9039	0.9992	.	1	0.015	1	0.6863	0.0022	0.9586
25	1	0.0093	1	0.5566	0.1973	0.9311	0.2276	0.3006	0.582	1	0.9358	1	1	0.0303	0.6472	0.384	0.5566	0.9958	1	0.0262	1	0.3438	0.7919	1	.	0.1368	1	0.9958	0.0255	1
26	0.0295	0.0001	0.5602	1	1	0.0008	0.0001	0.0001	1	0.6686	0.9978	0.3968	0.714	1	1	1	1	0.0026	0.0137	0.0001	0.066	0.0001	0.0003	0.015	0.1368	.	0.2035	0.955	1	0.6757
27	1	0.0055	1	0.6898	0.2843	0.8537	0.1545	0.2099	0.714	1	0.9771	1	1	0.0489	0.7733	0.5097	0.6898	0.9819	1	0.0159	1	0.2439	0.6686	1	1	0.2035	.	0.9994	0.0414	1
28	0.8432	0.0001	1	1	0.9842	0.1128	0.0052	0.0078	1	1	1	1	1	0.6328	1	0.9994	1	0.2738	0.6615	0.0004	0.9608	0.0097	0.0554	0.6863	0.9958	0.955	0.9994	.	0.5856	1
29	0.0045	0.0001	0.1703	0.9971	1	0.0001	0.0001	0.0001	0.9959	0.2321	0.8511	0.1005	0.2636	1	0.9913	0.9998	0.9971	0.0004	0.002	0.0001	0.011	0.0001	0.0001	0.0022	0.0255	1	0.0414	0.5856	.	0.2368
30	0.9923	0.0006	1	0.989	0.7888	0.3498	0.0242	0.0354	0.9916	1	1	1	1	0.2687	0.9961	0.9474	0.989	0.64	0.95	0.0019	0.9997	0.043	0.1994	0.9586	1	0.6757	1	1	0.2368	.

Sodium

1	.	1	0.1295	0.0001	0.6208	1	0.2007	0.0001	0.9698	0.924	1	0.0001	0.8455	0.0002	0.2158	0.0005	0.5064	1	1	0.2433	0.0592	1	0.0289	1	1	1	0.173	0.1851	1	0.0642
2	1	.	0.0575	0.0001	0.3823	0.9988	0.0941	0.0001	0.8532	0.7494	1	0.0001	0.6243	0.0001	0.1023	0.0002	0.2893	0.9999	1	0.1175	0.1329	1	0.0115	1	1	1	0.0795	0.0858	1	0.0267
3	0.1295	0.0575	.	0.6082	1	0.718	1	0.5317	0.9906	0.9981	0.0509	0.6231	0.9998	0.6873	1	0.8917	1	0.5651	0.4709	1	0.0001	0.4193	1	0.0302	0.4381	0.0398	1	1	0.2041	1
4	0.0001	0.0001	0.6082	.	0.1246	0.0027	0.4629	1	0.0215	0.0343	0.0001	1	0.0544	1	0.4386	1	0.1763	0.0015	0.001	0.3987	0.0001	0.0008	0.9446	0.0001	0.0009	0.0001	0.5128	0.49	0.0003	0.8083
5	0.6208	0.3823	1	0.1246	.	0.9976	1	0.0977	1	1	0.3521	0.1305	1	0.1591	1	0.319	1	0.9852	0.9656	1	0.0001	0.9479	0.9957	0.2425	0.9551	0.2964	1	1	0.7664	0.9999
6	1	0.9988	0.718	0.0027	0.9976	.	0.8424	0.002	1	1	0.998	0.0029	1	0.0038	0.8607	0.0101	0.9902	1	1	0.8888	0.0036	1	0.3046	0.9885	1	0.9951	0.8025	0.8212	1	0.5058
7	0.2007	0.0941	1	0.4629	1	0.8424	.	0.3923	0.9985	0.9998	0.0838	0.4773	1	0.5412	1	0.7845	1	0.7101	0.6166	1	0.0001	0.5615	1	0.051	0.5819	0.0663	1	1	0.3028	1

8	0.0001	0.0001	0.5317	1	0.0977	0.002	0.3923	.	0.0162	0.026	0.0001	1	0.0416	1	0.3699	1	0.1402	0.0011	0.0007	0.3334	0.0001	0.0006	0.9095	0.0001	0.0006	0.0001	0.4392	0.4176	0.0002	0.7424
9	0.9698	0.8532	0.9906	0.0215	1	1	0.9985	0.0162	.	1	0.8272	0.0227	1	0.0289	0.999	0.0703	1	1	1	0.9995	0.0004	0.9999	0.7991	0.6993	1	0.7696	0.997	0.9978	0.9932	0.9401
10	0.924	0.7494	0.9981	0.0343	1	1	0.9998	0.026	1	.	0.7169	0.0362	1	0.0456	0.9999	0.1071	1	1	0.9997	1	0.0003	0.9992	0.8906	0.5729	0.9994	0.6493	0.9996	0.9997	0.9756	0.9779
11	1	1	0.0509	0.0001	0.3521	0.998	0.0838	0.0001	0.8272	0.7169	.	0.0001	0.5891	0.0001	0.0912	0.0002	0.2639	0.9999	1	0.1051	0.1481	1	0.01	1	1	1	0.0706	0.0764	1	0.0235
12	0.0001	0.0001	0.6231	1	0.1305	0.0029	0.4773	1	0.0227	0.0362	0.0001	.	0.0573	1	0.4527	1	0.1842	0.0016	0.0011	0.4122	0.0001	0.0009	0.9501	0.0001	0.0009	0.0001	0.5276	0.5046	0.0003	0.8202
13	0.8455	0.6243	0.9998	0.0544	1	1	1	0.0416	1	1	0.5891	0.0573	.	0.0715	1	0.1603	1	0.9994	0.9976	1	0.0002	0.9951	0.952	0.4454	0.9962	0.5193	1	1	0.9343	0.9942
14	0.0002	0.0001	0.6873	1	0.1591	0.0038	0.5412	1	0.0289	0.0456	0.0001	1	0.0715	.	0.5158	1	0.2216	0.002	0.0014	0.4732	0.0001	0.0011	0.9698	0.0001	0.0012	0.0001	0.5927	0.5693	0.0004	0.8676
15	0.2158	0.1023	1	0.4386	1	0.8607	1	0.3699	0.999	0.9999	0.0912	0.4527	1	0.5158	.	0.7622	1	0.7341	0.6422	1	0.0001	0.5873	1	0.0557	0.6076	0.0723	1	1	0.3228	1
16	0.0005	0.0002	0.8917	1	0.319	0.0101	0.7845	1	0.0703	0.1071	0.0002	1	0.1603	1	0.7622	.	0.4171	0.0055	0.0038	0.7225	0.0001	0.0031	0.9981	0.0001	0.0033	0.0001	0.8263	0.8079	0.001	0.976
17	0.5064	0.2893	1	0.1763	1	0.9902	1	0.1402	1	1	0.2639	0.1842	1	0.2216	1	0.4171	.	0.96	0.9226	1	0.0001	0.8931	0.9991	0.1754	0.9047	0.2183	1	1	0.6587	1
18	1	0.9999	0.5651	0.0015	0.9852	1	0.7101	0.0011	1	1	0.9999	0.0016	0.9994	0.002	0.7341	0.0055	0.96	.	1	0.7732	0.0067	1	0.2007	0.9983	1	0.9995	0.6605	0.6832	1	0.3622
19	1	1	0.4709	0.001	0.9656	1	0.6166	0.0007	1	0.9997	1	0.0011	0.9976	0.0014	0.6422	0.0038	0.9226	1	.	0.6849	0.0097	1	0.1516	0.9996	1	0.9999	0.5651	0.5885	1	0.2862
20	0.2433	0.1175	1	0.3987	1	0.8888	1	0.3334	0.9995	1	0.1051	0.4122	1	0.4732	1	0.7225	1	0.7732	0.6849	.	0.0001	0.6309	1	0.0647	0.651	0.0837	1	1	0.3586	1
21	0.0592	0.1329	0.0001	0.0001	0.0001	0.0036	0.0001	0.0001	0.0004	0.0003	0.1481	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0067	0.0097	0.0001	.	0.012	0.0001	0.2264	0.0111	0.1823	0.0001	0.0001	0.0345	0.0001
22	1	1	0.4193	0.0008	0.9479	1	0.5615	0.0006	0.9999	0.9992	1	0.0009	0.9951	0.0011	0.5873	0.0031	0.8931	1	1	0.6309	0.012	.	0.1281	0.9999	1	1	0.5105	0.5335	1	0.2476
23	0.0289	0.0115	1	0.9446	0.9957	0.3046	1	0.9095	0.7991	0.8906	0.01	0.9501	0.952	0.9698	1	0.9981	0.9991	0.2007	0.1516	1	0.0001	0.1281	.	0.0057	0.1364	0.0076	1	1	0.0498	1
24	1	1	0.0302	0.0001	0.2425	0.9885	0.051	0.0001	0.6993	0.5729	1	0.0001	0.4454	0.0001	0.0557	0.0001	0.1754	0.9983	0.9996	0.0647	0.2264	0.9999	0.0057	.	0.9998	1	0.0426	0.0462	1	0.0136
25	1	1	0.4381	0.0009	0.9551	1	0.5819	0.0006	1	0.9994	1	0.0009	0.9962	0.0012	0.6076	0.0033	0.9047	1	1	0.651	0.0111	1	0.1364	0.9998	.	1	0.5306	0.5538	1	0.2614
26	1	1	0.0398	0.0001	0.2964	0.9951	0.0663	0.0001	0.7696	0.6493	1	0.0001	0.5193	0.0001	0.0723	0.0001	0.2183	0.9995	0.9999	0.0837	0.1823	1	0.0076	1	1	.	0.0556	0.0603	1	0.0181
27	0.173	0.0795	1	0.5128	1	0.8025	1	0.4392	0.997	0.9996	0.0706	0.5276	1	0.5927	1	0.8263	1	0.6605	0.5651	1	0.0001	0.5105	1	0.0426	0.5306	0.0556	.	1	0.2652	1
28	0.1851	0.0858	1	0.49	1	0.8212	1	0.4176	0.9978	0.9997	0.0764	0.5046	1	0.5693	1	0.8079	1	0.6832	0.5885	1	0.0001	0.5335	1	0.0462	0.5538	0.0603	1	.	0.2818	1
29	1	1	0.2041	0.0003	0.7664	1	0.3028	0.0002	0.9932	0.9756	1	0.0003	0.9343	0.0004	0.3228	0.001	0.6587	1	1	0.3586	0.0345	1	0.0498	1	1	1	0.2652	0.2818	.	0.1065
30	0.0642	0.0267	1	0.8083	0.9999	0.5058	1	0.7424	0.9401	0.9779	0.0235	0.8202	0.9942	0.8676	1	0.976	1	0.3622	0.2862	1	0.0001	0.2476	1	0.0136	0.2614	0.0181	1	1	0.1065	.

Calcium

1	.	1	1	0.0093	0.9915	0.6729	1	0.9999	1	0.0002	1	0.0281	1	0.9976	0.9974	1	0.4309	0.9855	1	0.0001	1	0.4512	1	1	1	0.6746	0.0001	0.0939	0.4656	0.0001
2	1	.	1	0.0052	0.9987	0.5264	1	0.9988	1	0.0001	1	0.0476	1	0.9998	0.9997	1	0.5744	0.9498	0.9998	0.0001	1	0.5961	1	1	1	0.8076	0.0001	0.0573	0.3345	0.0001
3	1	1	.	0.0279	0.9078	0.9057	1	1	1	0.0007	0.9998	0.0094	1	0.9535	0.9508	1	0.207	0.9997	1	0.0001	1	0.2199	0.9969	1	1	0.3903	0.0001	0.2274	0.7514	0.0001
4	0.0093	0.0052	0.0279	.	0.0001	0.9056	0.0063	0.1766	0.0065	0.9994	0.0009	0.0001	0.0031	0.0001	0.0001	0.0415	0.0001	0.432	0.1237	0.0002	0.0021	0.0001	0.0004	0.008	0.0035	0.0001	0.4078	1	0.9797	0.0001
5	0.9915	0.9987	0.9078	0.0001	.	0.0283	0.9975	0.4209	0.9973	0.0001	1	0.6713	0.9999	1	1	0.8368	0.9999	0.1704	0.5337	0.0001	1	1	1	0.9945	0.9998	1	0.0001	0.0013	0.013	0.0001
6	0.6729	0.5264	0.9057	0.9056	0.0283	.	0.573	0.9998	0.5798	0.1466	0.1815	0.0001	0.4013	0.0412	0.0401	0.9542	0.0011	1	0.9986	0.0001	0.322	0.0012	0.104	0.6359	0.4267	0.003	0.0032	1	1	0.0001
7	1	1	1	0.0063	0.9975	0.573	.	0.9994	1	0.0001	1	0.0404	1	0.9995	0.9994	1	0.5277	0.9647	0.9999	0.0001	1	0.5493	1	1	1	0.7682	0.0001	0.0672	0.3738	0.0001
8	0.9999	0.9988	1	0.1766	0.4209	0.9998	0.9994	.	0.9995	0.0062	0.9107	0.001	0.9931	0.5208	0.5132	1	0.0341	1	1	0.0001	0.9819	0.0368	0.784	0.9998	0.995	0.0805	0.0001	0.7193	0.9951	0.0001
9	1	1	1	0.0065	0.9973	0.5798	1	0.9995	.	0.0001	1	0.0394	1	0.9994	0.9994	1	0.521	0.9666	0.9999	0.0001	1	0.5425	1	1	1	0.7622	0.0001	0.0688	0.3797	0.0001
10	0.0002	0.0001	0.0007	0.9994	0.0001	0.1466	0.0001	0.0062	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0011	0.0001	0.0235	0.0039	0.0107	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.9971	0.8015	0.266	0.0063

11	1	1	0.9998	0.0009	1	0.1815	1	0.9107	1	0.0001	.	0.1945	1	1	1	0.9989	0.9287	0.6264	0.9595	0.0001	1	0.9381	1	1	1	0.9913	0.0001	0.0116	0.095	0.0001
12	0.0281	0.0476	0.0094	0.0001	0.6713	0.0001	0.0404	0.001	0.0394	0.0001	0.1945	.	0.0748	0.5675	0.5752	0.0061	0.9998	0.0003	0.0017	0.0001	0.1017	0.9996	0.3164	0.0322	0.0681	0.9912	0.0001	0.0001	0.0001	0.0001
13	1	1	1	0.0031	0.9999	0.4013	1	0.9931	1	0.0001	1	0.0748	.	1	1	1	0.7042	0.8861	0.9985	0.0001	1	0.7247	1	1	1	0.8989	0.0001	0.0361	0.2383	0.0001
14	0.9976	0.9998	0.9535	0.0001	1	0.0412	0.9995	0.5208	0.9994	0.0001	1	0.5675	1	.	1	0.9046	0.9995	0.2295	0.638	0.0001	1	0.9996	1	0.9986	1	1	0.0001	0.0019	0.0192	0.0001
15	0.9974	0.9997	0.9508	0.0001	1	0.0401	0.9994	0.5132	0.9994	0.0001	1	0.5752	1	1	.	0.9003	0.9996	0.2247	0.6304	0.0001	1	0.9997	1	0.9985	1	1	0.0001	0.0019	0.0187	0.0001
16	1	1	1	0.0415	0.8368	0.9542	1	1	1	0.0011	0.9989	0.0061	1	0.9046	0.9003	.	0.1499	1	1	0.0001	1	0.16	0.9889	1	1	0.2995	0.0001	0.3042	0.842	0.0001
17	0.4309	0.5744	0.207	0.0001	0.9999	0.0011	0.5277	0.0341	0.521	0.0001	0.9287	0.9998	0.7042	0.9995	0.9996	0.1499	.	0.0092	0.0516	0.0001	0.7887	1	0.9828	0.4663	0.6773	1	0.0001	0.0001	0.0005	0.0001
18	0.9855	0.9498	0.9997	0.432	0.1704	1	0.9647	1	0.9666	0.0235	0.6264	0.0003	0.8861	0.2295	0.2247	1	0.0092	.	1	0.0001	0.8207	0.01	0.4475	0.9793	0.9025	0.0236	0.0004	0.9523	1	0.0001
19	1	0.9998	1	0.1237	0.5337	0.9986	0.9999	1	0.9999	0.0039	0.9595	0.0017	0.9985	0.638	0.6304	1	0.0516	1	.	0.0001	0.9948	0.0557	0.8729	1	0.999	0.1178	0.0001	0.6046	0.9827	0.0001
20	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0107	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.3421	0.0001	0.0001	1
21	1	1	1	0.0021	1	0.322	1	0.9819	1	0.0001	1	0.1017	1	1	1	1	0.7887	0.8207	0.9948	0.0001	.	0.8066	1	1	1	0.9437	0.0001	0.0257	0.1831	0.0001
22	0.4512	0.5961	0.2199	0.0001	1	0.0012	0.5493	0.0368	0.5425	0.0001	0.9381	0.9996	0.7247	0.9996	0.9997	0.16	1	0.01	0.0557	0.0001	0.8066	.	0.9861	0.4872	0.6983	1	0.0001	0.0001	0.0005	0.0001
23	1	1	0.9969	0.0004	1	0.104	1	0.784	1	0.0001	1	0.3164	1	1	1	0.9889	0.9828	0.4475	0.8729	0.0001	1	0.9861	.	1	1	0.9992	0.0001	0.0057	0.0516	0.0001
24	1	1	1	0.008	0.9945	0.6359	1	0.9998	1	0.0002	1	0.0322	1	0.9986	0.9985	1	0.4663	0.9793	1	0.0001	1	0.4872	1	.	1	0.7107	0.0001	0.083	0.4302	0.0001
25	1	1	1	0.0035	0.9998	0.4267	1	0.995	1	0.0001	1	0.0681	1	1	1	1	0.6773	0.9025	0.999	0.0001	1	0.6983	1	1	.	0.8822	0.0001	0.0399	0.2569	0.0001
26	0.6746	0.8076	0.3903	0.0001	1	0.003	0.7682	0.0805	0.7622	0.0001	0.9913	0.9912	0.8989	1	1	0.2995	1	0.0236	0.1178	0.0001	0.9437	1	0.9992	0.7107	0.8822	.	0.0001	0.0001	0.0013	0.0001
27	0.0001	0.0001	0.0001	0.4078	0.0001	0.0032	0.0001	0.0001	0.0001	0.9971	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	0.0001	0.3421	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0637	0.0073	0.2406
28	0.0939	0.0573	0.2274	1	0.0013	1	0.0672	0.7193	0.0688	0.8015	0.0116	0.0001	0.0361	0.0019	0.0019	0.3042	0.0001	0.9523	0.6046	0.0001	0.0257	0.0001	0.0057	0.083	0.0399	0.0001	0.0637	.	1	0.0001
29	0.4656	0.3345	0.7514	0.9797	0.013	1	0.3738	0.9951	0.3797	0.266	0.095	0.0001	0.2383	0.0192	0.0187	0.842	0.0005	1	0.9827	0.0001	0.1831	0.0005	0.0516	0.4302	0.2569	0.0013	0.0073	1	.	0.0001
30	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0063	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.2406	0.0001	0.0001	.

Potassium

1	.	0.5738	1	1	0.0001	1	1	0.9891	0.0013	0.0001	0.8906	1	0.0001	0.0001	0.0001	1	0.0001	1	1	0.9992	0.9847	1	0.9504	0.9998	1	0.0001	0.8186	0.9999	0.0001	0.9998
2	0.5738	.	0.3023	0.4094	0.0001	0.9004	0.0978	1	0.5606	0.0001	0.0057	0.2416	0.0008	0.0001	0.0001	0.9792	0.0008	0.9489	0.8975	0.0379	0.0158	0.1117	0.0093	0.9994	0.4428	0.0001	0.0038	0.0621	0.0011	0.0475
3	1	0.3023	.	1	0.0001	1	1	0.8914	0.0004	0.0001	0.9889	1	0.0001	0.0001	0.0003	0.9998	0.0001	1	1	1	0.9997	1	0.9975	0.9876	1	0.0001	0.9709	1	0.0001	1
4	1	0.4094	1	.	0.0001	1	1	0.9516	0.0006	0.0001	0.9645	1	0.0001	0.0001	0.0002	1	0.0001	1	1	1	0.9979	1	0.9887	0.9972	1	0.0001	0.926	1	0.0001	1
5	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0278	1	0.0001	0.0001	0.9995	0.9997	0.0001	0.0001	0.9995	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.9983	0.0001
6	1	0.9004	1	1	0.0001	.	0.9965	1	0.0058	0.0001	0.5569	1	0.0001	0.0001	0.0001	1	0.0001	1	1	0.9487	0.8078	0.998	0.6819	1	1	0.0001	0.4556	0.9841	0.0001	0.9685
7	1	0.0978	1	1	0.0001	0.9965	.	0.553	0.0001	0.0001	1	1	0.0001	0.0001	0.0013	0.9677	0.0001	0.9884	0.9968	1	1	1	1	0.8205	1	0.0001	0.9998	1	0.0001	1
8	0.9891	1	0.8914	0.9516	0.0001	1	0.553	.	0.1002	0.0001	0.0665	0.8335	0.0001	0.0001	0.0001	1	0.0001	1	1	0.3021	0.1561	0.5947	0.1009	1	0.9631	0.0001	0.0465	0.4212	0.0001	0.3535
9	0.0013	0.5606	0.0004	0.0006	0.0278	0.0058	0.0001	0.1002	.	0.1367	0.0001	0.0003	0.4657	0.0008	0.0001	0.0133	0.4688	0.0087	0.0057	0.0001	0.0001	0.0001	0.0001	0.0378	0.0007	0.0103	0.0001	0.0001	0.5405	0.0001
10	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.1367	.	0.0001	0.0001	1	0.9378	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	1	0.0001
11	0.8906	0.0057	0.9889	0.9645	0.0001	0.5569	1	0.0665	0.0001	0.0001	.	0.9958	0.0001	0.0001	0.0267	0.3542	0.0001	0.4545	0.5619	1	1	0.9999	1	0.1656	0.9532	0.0001	1	1	0.0001	1
12	1	0.2416	1	1	0.0001	1	1	0.8335	0.0003	0.0001	0.9958	.	0.0001	0.0001	0.0004	0.999	0.0001	0.9999	1	1	1	1	0.9993	0.9725	1	0.0001	0.9867	1	0.0001	1
13	0.0001	0.0008	0.0001	0.0001	0.9995	0.0001	0.0001	0.0001	0.4657	1	0.0001	0.0001	.	0.5628	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9841	0.0001	0.0001	1	0.0001

14	0.0001	0.0001	0.0001	0.0001	0.9997	0.0001	0.0001	0.0001	0.0008	0.9378	0.0001	0.0001	0.5628	.	0.0001	0.0001	0.5596	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.4873	0.0001
15	0.0001	0.0001	0.0003	0.0002	0.0001	0.0001	0.0013	0.0001	0.0001	0.0001	0.0267	0.0004	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0039	0.0098	0.0011	0.0167	0.0001	0.0001	0.0001	0.0388	0.0022	0.0001	0.003
16	1	0.9792	0.9998	1	0.0001	1	0.9677	1	0.0133	0.0001	0.3542	0.999	0.0001	0.0001	0.0001	.	0.0001	1	1	0.825	0.6063	0.9773	0.4679	1	1	0.0001	0.2736	0.9158	0.0001	0.8709
17	0.0001	0.0008	0.0001	0.0001	0.9995	0.0001	0.0001	0.0001	0.4688	1	0.0001	0.0001	1	0.5596	0.0001	0.0001	.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9836	0.0001	0.0001	1	0.0001
18	1	0.9489	1	1	0.0001	1	0.9884	1	0.0087	0.0001	0.4545	0.9999	0.0001	0.0001	0.0001	1	0.0001	.	1	0.9001	0.7157	0.9926	0.5781	1	1	0.0001	0.3611	0.9608	0.0001	0.9323
19	1	0.8975	1	1	0.0001	1	0.9968	1	0.0057	0.0001	0.5619	1	0.0001	0.0001	0.0001	1	0.0001	1	.	0.9505	0.8119	0.9982	0.6868	1	1	0.0001	0.4604	0.9849	0.0001	0.9698
20	0.9992	0.0379	1	1	0.0001	0.9487	1	0.3021	0.0001	0.0001	1	1	0.0001	0.0001	0.0039	0.825	0.0001	0.9001	0.9505	.	1	1	1	0.5612	0.9999	0.0001	1	1	0.0001	1
21	0.9847	0.0158	0.9997	0.9979	0.0001	0.8078	1	0.1561	0.0001	0.0001	1	1	0.0001	0.0001	0.0098	0.6063	0.0001	0.7157	0.8119	1	.	1	1	0.3397	0.9966	0.0001	1	1	0.0001	1
22	1	0.1117	1	1	0.0001	0.998	1	0.5947	0.0001	0.0001	0.9999	1	0.0001	0.0001	0.0011	0.9773	0.0001	0.9926	0.9982	1	1	.	1	0.8516	1	0.0001	0.9996	1	0.0001	1
23	0.9504	0.0093	0.9975	0.9887	0.0001	0.6819	1	0.1009	0.0001	0.0001	1	0.9993	0.0001	0.0001	0.0167	0.4679	0.0001	0.5781	0.6868	1	1	1	.	0.237	0.9837	0.0001	1	1	0.0001	1
24	0.9998	0.9994	0.9876	0.9972	0.0001	1	0.8205	1	0.0378	0.0001	0.1656	0.9725	0.0001	0.0001	0.0001	1	0.0001	1	1	0.5612	0.3397	0.8516	0.237	.	0.9983	0.0001	0.1207	0.7006	0.0001	0.6252
25	1	0.4428	1	1	0.0001	1	1	0.9631	0.0007	0.0001	0.9532	1	0.0001	0.0001	0.0001	1	0.0001	1	1	0.9999	0.9966	1	0.9837	0.9983	.	0.0001	0.9079	1	0.0001	1
26	0.0001	0.0001	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0103	1	0.0001	0.0001	0.9841	1	0.0001	0.0001	0.9836	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	.	0.0001	0.0001	0.9687	0.0001
27	0.8186	0.0038	0.9709	0.926	0.0001	0.4556	0.9998	0.0465	0.0001	0.0001	1	0.9867	0.0001	0.0001	0.0388	0.2736	0.0001	0.3611	0.4604	1	1	0.9996	1	0.1207	0.9079	0.0001	.	1	0.0001	1
28	0.9999	0.0621	1	1	0.0001	0.9841	1	0.4212	0.0001	0.0001	1	1	0.0001	0.0001	0.0022	0.9158	0.0001	0.9608	0.9849	1	1	1	1	0.7006	1	0.0001	1	.	0.0001	1
29	0.0001	0.0011	0.0001	0.0001	0.9983	0.0001	0.0001	0.0001	0.5405	1	0.0001	0.0001	1	0.4873	0.0001	0.0001	1	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.9687	0.0001	0.0001	.	0.0001
30	0.9998	0.0475	1	1	0.0001	0.9685	1	0.3535	0.0001	0.0001	1	1	0.0001	0.0001	0.003	0.8709	0.0001	0.9323	0.9698	1	1	1	1	0.6252	1	0.0001	1	1	0.0001	.

Magnesium

1	.	0.0664	0.0166	0.0002	1	0.4069	0.0299	0.0001	0.882	1	0.9999	0.2706	1	1	0.0001	0.0007	0.9721	0.9996	0.1067	0.0922	0.9241	1	0.9291	0.0012	1	0.0002	0.0001	0.0293	0.0422	0.185
2	0.0664	.	1	0.8403	0.1086	1	1	0.0127	0.9905	0.0892	0.629	1	0.0648	0.1172	0.0027	0.9874	0.9404	0.6998	1	1	0.0003	0.0035	0.9777	0.9969	0.2317	0.903	0.4358	1	1	1
3	0.0166	1	.	0.9904	0.0287	0.9983	1	0.0522	0.8412	0.023	0.2773	0.9999	0.0161	0.0313	0.0124	1	0.6522	0.3326	1	1	0.0001	0.0008	0.7708	1	0.0703	0.997	0.805	1	1	1
4	0.0002	0.8403	0.9904	.	0.0003	0.2723	0.9589	0.8346	0.0539	0.0002	0.0053	0.409	0.0002	0.0003	0.4654	1	0.0251	0.007	0.7186	0.7598	0.0001	0.0001	0.0397	1	0.0009	1	1	0.9608	0.9207	0.5409
5	1	0.1086	0.0287	0.0003	.	0.5498	0.0509	0.0001	0.9536	1	1	0.3898	1	1	0.0001	0.0013	0.9936	1	0.1688	0.1475	0.8318	0.9995	0.977	0.0022	1	0.0005	0.0001	0.0498	0.0707	0.2787
6	0.4069	1	0.9983	0.2723	0.5498	.	0.9999	0.0011	1	0.4898	0.9911	1	0.4002	0.5738	0.0002	0.5956	1	0.9962	1	1	0.0037	0.0387	1	0.7155	0.7928	0.3469	0.0739	0.9999	1	1
7	0.0299	1	1	0.9589	0.0509	0.9999	.	0.0295	0.9349	0.0411	0.4083	1	0.0292	0.0553	0.0067	0.9993	0.7997	0.476	1	1	0.0001	0.0014	0.8901	0.9999	0.1187	0.9818	0.6586	1	1	1
8	0.0001	0.0127	0.0522	0.8346	0.0001	0.0011	0.0295	.	0.0001	0.0001	0.0001	0.0021	0.0001	0.0001	1	0.4971	0.0001	0.0001	0.0073	0.0087	0.0001	0.0001	0.0001	0.3831	0.0001	0.7545	0.9937	0.0302	0.0208	0.0036
9	0.882	0.9905	0.8412	0.0539	0.9536	1	0.9349	0.0001	.	0.9295	1	1	0.8774	0.9613	0.0001	0.1722	1	1	0.9984	0.9971	0.0274	0.2108	1	0.2434	0.9961	0.0749	0.011	0.9322	0.9678	0.9999
10	1	0.0892	0.023	0.0002	1	0.4898	0.0411	0.0001	0.9295	.	1	0.338	1	1	0.0001	0.001	0.9877	0.9999	0.1406	0.1222	0.8746	0.9999	0.962	0.0017	1	0.0004	0.0001	0.0402	0.0575	0.237
11	0.9999	0.629	0.2773	0.0053	1	0.9911	0.4083	0.0001	1	1	.	0.9587	0.9999	1	0.0001	0.0209	1	1	0.7653	0.7244	0.213	0.7583	1	0.0327	1	0.0077	0.0009	0.4027	0.4988	0.8981
12	0.2706	1	0.9999	0.409	0.3898	1	1	0.0021	1	0.338	0.9587	.	0.2654	0.4113	0.0004	0.7575	0.9997	0.9772	1	1	0.0019	0.021	1	0.8556	0.6364	0.5004	0.1273	1	1	1
13	1	0.0648	0.0161	0.0002	1	0.4002	0.0292	0.0001	0.8774	1	0.9999	0.2654	.	1	0.0001	0.0007	0.9703	0.9995	0.1042	0.09	0.9276	1	0.9257	0.0012	1	0.0002	0.0001	0.0285	0.0411	0.181
14	1	0.1172	0.0313	0.0003	1	0.5738	0.0553	0.0001	0.9613	1	1	0.4113	1	.	0.0001	0.0015	0.9952	1	0.1811	0.1585	0.8131	0.9993	0.9815	0.0024	1	0.0005	0.0001	0.0541	0.0766	0.2964
15	0.0001	0.0027	0.0124	0.4654	0.0001	0.0002	0.0067	1	0.0001	0.0001	0.0001	0.0004	0.0001	0.0001	.	0.1895	0.0001	0.0001	0.0015	0.0019	0.0001	0.0001	0.0001	0.1314	0.0001	0.3769	0.8626	0.0069	0.0046	0.0007
16	0.0007	0.9874	1	1	0.0013	0.5956	0.9993	0.4971	0.1722	0.001	0.0209	0.7575	0.0007	0.0015	0.1895	.	0.0885	0.0273	0.9559	0.969	0.0001	0.0001	0.1324	1	0.0036	1	1	0.9994	0.9972	0.8662

17	0.9721	0.9404	0.6522	0.0251	0.9936	1	0.7997	0.0001	1	0.9877	1	0.9997	0.9703	0.9952	0.0001	0.0885	.	1	0.9809	0.9717	0.0586	0.3659	1	0.1308	0.9999	0.0357	0.0048	0.7945	0.871	0.9975
18	0.9996	0.6998	0.3326	0.007	1	0.9962	0.476	0.0001	1	0.9999	1	0.9772	0.9995	1	0.0001	0.0273	1	.	0.8253	0.7888	0.1731	0.6911	1	0.0424	1	0.0101	0.0013	0.47	0.5706	0.9344
19	0.1067	1	1	0.7186	0.1688	1	1	0.0073	0.9984	0.1406	0.7653	1	0.1042	0.1811	0.0015	0.9559	0.9809	0.8253	.	1	0.0005	0.0062	0.995	0.9844	0.3359	0.8039	0.3124	1	1	1
20	0.0922	1	1	0.7598	0.1475	1	1	0.0087	0.9971	0.1222	0.7244	1	0.09	0.1585	0.0019	0.969	0.9717	0.7888	1	.	0.0004	0.0052	0.9916	0.9901	0.3004	0.8391	0.3488	1	1	1
21	0.9241	0.0003	0.0001	0.0001	0.8318	0.0037	0.0001	0.0001	0.0274	0.8746	0.213	0.0019	0.9276	0.8131	0.0001	0.0001	0.0586	0.1731	0.0005	0.0004	.	1	0.0376	0.0001	0.5987	0.0001	0.0001	0.0001	0.0002	0.0011
22	1	0.0035	0.0008	0.0001	0.9995	0.0387	0.0014	0.0001	0.2108	0.9999	0.7583	0.021	1	0.9993	0.0001	0.0001	0.3659	0.6911	0.0062	0.0052	1	.	0.2672	0.0001	0.9865	0.0001	0.0001	0.0014	0.0021	0.0125
23	0.9291	0.9777	0.7708	0.0397	0.977	1	0.8901	0.0001	1	0.962	1	1	0.9257	0.9815	0.0001	0.1324	1	1	0.995	0.9916	0.0376	0.2672	.	0.1908	0.9988	0.0557	0.0079	0.8863	0.9386	0.9997
24	0.0012	0.9969	1	1	0.0022	0.7155	0.9999	0.3831	0.2434	0.0017	0.0327	0.8556	0.0012	0.0024	0.1314	1	0.1308	0.0424	0.9844	0.9901	0.0001	0.0001	0.1908	.	0.0059	1	0.9997	0.9999	0.9996	0.9338
25	1	0.2317	0.0703	0.0009	1	0.7928	0.1187	0.0001	0.9961	1	1	0.6364	1	1	0.0001	0.0036	0.9999	1	0.3359	0.3004	0.5987	0.9865	0.9988	0.0059	.	0.0013	0.0002	0.1164	0.1593	0.4992
26	0.0002	0.903	0.997	1	0.0005	0.3469	0.9818	0.7545	0.0749	0.0004	0.0077	0.5004	0.0002	0.0005	0.3769	1	0.0357	0.0101	0.8039	0.8391	0.0001	0.0001	0.0557	1	0.0013	.	1	0.9829	0.9592	0.6376
27	0.0001	0.4358	0.805	1	0.0001	0.0739	0.6586	0.9937	0.011	0.0001	0.0009	0.1273	0.0001	0.0001	0.8626	1	0.0048	0.0013	0.3124	0.3488	0.0001	0.0001	0.0079	0.9997	0.0002	1	.	0.6647	0.5631	0.1924
28	0.0293	1	1	0.9608	0.0498	0.9999	1	0.0302	0.9322	0.0402	0.4027	1	0.0285	0.0541	0.0069	0.9994	0.7945	0.47	1	1	0.0001	0.0014	0.8863	0.9999	0.1164	0.9829	0.6647	.	1	1
29	0.0422	1	1	0.9207	0.0707	1	1	0.0208	0.9678	0.0575	0.4988	1	0.0411	0.0766	0.0046	0.9972	0.871	0.5706	1	1	0.0002	0.0021	0.9386	0.9996	0.1593	0.9592	0.5631	1	.	1
30	0.185	1	1	0.5409	0.2787	1	1	0.0036	0.9999	0.237	0.8981	1	0.181	0.2964	0.0007	0.8662	0.9975	0.9344	1	1	0.0011	0.0125	0.9997	0.9338	0.4992	0.6376	0.1924	1	1	.