Are you really going to eat that?

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The answer to the question "Are you really going to eat that?" is most likely to be "Why not?". Such a response underlies an inherent trust in the integrity of the food we consume. Consumers generally trust the integrity of the food because according to Franz Kafka: "So long as you have food in your mouth, you have solved all the questions for the time being".

Food production has changed considerably after the green revolution. Modern farming practices are becoming increasingly more mechanized in order to minimize input costs and maximize outputs. However, it is estimated that by 2030, food production will need to increase by at least 50% to meet the demands of the growing world population (FAO 2012). Despite an increase in food production, it is estimated that at least one billion tonnes of food is wasted annually (FAO 2011). The wasted food could feed approximately two billion people annually. It is estimated that most of the food waste occurs between production and retailing.

Processed foods are becoming increasingly popular among consumers since they provide consumers with variety, they are convenient in terms of preparation and they are relatively cheap (Luiten *et al*. 2016). It is estimated that processed foods account for 75% of food sales in the world (approximately $3.2 trillion). Unfortunately, processed and especially ultra-processed foods are increasingly being linked to lifestyle diseases such as obesity, hypertension and cardiovascular disease also in children (Fernández-Alvira *et al*. 2015; Monteiro *et al*. 2013; Stuckler *et al*. 2012; Wirfält *et al*. 2015). Ultra-processed foods reduce food to an ingredient list of synthetic chemicals. Ann Wigmore who today would be considered a "holistic nutritionist", suggested that "The food you eat can either be the safest and most powerful form of medicine or the slowest form of poison".

Processed foods are advertised in terms of specific beneficial claims for the consumer. It is therefore important that the integrity of food be maintained from primary production, through to storage, processing, packaging, distribution, retailing and consumption. Food integrity is a relatively new concept in food science and refers to its quality, authenticity and safety (Hoorfar *et al*. 2011). Food quality refers to different inherent characteristics of a food that is acceptable to and expected by consumers including product size as defined by volume or weight. Food authenticity refers to claims made with regard to the origin, species content and product characteristics of food (Reid *et al*. 2006). Food safety is an all-encompassing term that refers to the safety of food in its broadest context including foodborne pathogens and toxic chemicals (Tritscher *et al*. 2013).

In order for food production to become sustainable it must also be environmentally as well as economically sustainable. Furthermore, food production practices should not jeopardise the integrity of food. There is an international research focus on developing technology to verify food integrity in the face of modern food production (Aung and Yoon 2014). Although diagnostics based on DNA technology are well established in medicine, these are now being used more frequently in the verification of food claims pertaining to food safety and authenticity. DNA is rightly referred to as the blueprint of life since it determines the cellular properties and function of the proteins it encodes. Since DNA is characteristic of a particular species it can be used to verify the presence or absence of product claims with regard to a food. One of the first applications of DNA technology to verify food claims was with regard to the detection of genetically modified (GM) foods.

Genetically modified (GM) crops are often branded by “scientists, politicians, industry representatives and environmentalists” as “the solution to world hunger” or “as a pointless but dramatic threat to health and safety”. With neither position being “well founded” (Whitty *et al*. 2013). As a result, the potential and danger of GM crops is often overstated. A GM crop is defined as an organism wherein the genetic material has been altered in a way that does not occur naturally by mating and/or through natural recombination (WHO 2014). The purpose of genetic manipulation is to provide the crop with a beneficial trait including those for agronomic production, as well as health and nutritional properties (Viljoen *et al*. 2006).

The major GM crops produced in the world include canola (24% of world production is GM), cotton (75% of world production is GM), maize (29% of world production is GM) and soybean (83% of world production is GM) (James 2015). The major GM traits are herbicide tolerance and insect resistance with many crops containing stacked traits for both herbicide tolerance and insect resistance. In South Africa, it is estimated that 84% of white maize, 91% of yellow maize, 92% of soybean and 100% of cotton production is GM. The major GM traits in South Africa are also herbicide tolerance and insect resistance.

Insect resistant GM crops are genetically engineered to contain an endo-toxin gene from bacteria that is toxic to certain genera of insect pests. When the target insect feeds on the insect resistant GM crop, it ingests the endo-toxin and this results in the death of the insect. Insect resistant GM crops have reduced the application of insecticides in agriculture. Compared to this, herbicide tolerant crops have been genetically altered to make them tolerant to herbicides. Herbicide tolerant crops allow for crop management during the growing season through the application of herbicides to kill the weeds but not the GM crop. The active ingredient in the major herbicide tolerant crops is glyphosate. Glyphosate is also used to desiccate crops prior to harvesting. Overall, it is considered that GM crops have benefited the environment. A survey of the impact of insect resistant and herbicide tolerant GM crops from 1996 to 2011 has estimated that insect resistant crops have resulted in a reduction of the application of approximately 56 million kg of insecticide whereas the use of glyphosate based herbicide has increased to 239 million kg over the period studied (Benbrook 2012).

GM crops undergo a rigorous risk assessment prior to commercialization. There is currently no evidence that the genetic alteration of the DNA of GM crops poses any safety risk (Nicolia *et al*. 2014). However, in 2015, a World Health Organization (WHO) report by the International Agency for Research on Cancer (IARC) concluded that glyphosate (the active ingredient in the herbicide sprayed on herbicide tolerant crops) is "probably carcinogenic to humans" (IARC 2015). The WHO IARC conclusion, that glyphosate which is the active ingredient in most herbicide tolerant GM crops, is “probably carcinogenic to humans” was based on “limited evidence in humans” and “sufficient evidence in experimental animals”. The IARC report concluded that there was strong evidence that glyphosate and glyphosate-based formulations is genotoxic” meaning it can cause DNA and chromosomal damage.

As to be expected, the WHO report has met with an extreme response. This is understandable considering that glyphosate is currently the most widely used herbicide in the world and it represents a global industry estimated at $4.8 billion. Although it is currently uncertain to what extent the use of glyphosate in herbicide tolerant crops poses safety concerns, it has recently been determined that glyphosate residue is present in GM grain as well as food products (Bøhn *et al*. 2014; Then 2103; Rubio and Guo 2015). Furthermore, glyphosate cannot be removed from food by washing, cooking or processing (EFSA 2009). Thus question of whether glyphosate in food is safe in the long term needs to be addressed through research.

Many consumers want GM food labelled due to concerns about long term safety (Bawa and Anilakumar 2013; Landrigan and Benbrook 2015). In response to consumer pressure, many countries have introduced mandatory GM labelling (Viljoen *et al*. 2006). It is important to note that GM labelling is not based on the safety of GM food. GM labelling is solely about consumer autonomy and the consumer’s right to information and to be able to choose between GM and non-GM food (Botha and Viljoen 2009). Currently, the Consumer Protection Act (2008) mandates the labelling of GM ingredients in packaged food products in South Africa as follows: 1. Any ingredient in a food product containing 5% or more GM must be labelled as “genetically modified”. 2. Voluntary non-GM labelling may be applied to ingredients that contain less than 1% GM. 3. Since South Africa is a GM crop producing country, companies may use a cost effective option of indicating that the food “may contain genetically modified ingredients” where it is “scientifically impractical or not feasible” to test for the presence of GM in a food product. Thus South Africa serves as a case study for other resource poor countries to implement mandatory GM labelling (Viljoen and Marx 2013).

The research conducted by the GMO Testing Facility has contributed to inform GM related discussions including GM labelling. The technology for GM diagnostic testing was established through a research project initiated in 1999 and resulted in the establishment of the GMO Testing Facility in 2003. The GMO Testing Facility is nationally and internationally recognized and is approved by the South African government to perform GM status certification. The diagnostic platform established in the GMO Testing Facility is used to fund and support research at the University of the Free State.

With GM labelling now well established in South Africa, the question is what is the next challenge? As our understanding of food integrity develops we are discovering many new challenges and questions that require answers. The use of molecular diagnostic technology in maintaining food integrity is still in its infancy. The recent “horse meat” scandal in Europe in 2013, involving an estimated 330 tonnes of processed meat, highlights the need for continued research into food authenticity and safety testing (Barnett *et al*. 2016; Premanandh 2013). Furthermore, the potential presence of glyphosate in the food chain requires further research to determine the effect of chronic exposure to low levels of herbicide. So the answer to the question “Are you really going to eat that?" is "Yes! But let's continue to make sure our food is safe and authentic!".

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