

# ETHICAL TOPICS IN FOOD SCIENCE AND TECHNOLOGY: A BIRD'S EYE VIEW

## Abstract

Amidst rapid innovations being made in the food science and technology sector to meet the urgent needs of a rapidly expanding global population, it is imperative to analyze these developments from an ethical perspective to ensure their acceptability. In this chapter, the current topics related to food science and technology (such as genetically modified food, food additives, novel food packaging, and cultured meat) being discussed from an ethical perspective have been summarized.

**Keywords:** Food Science, Ethics, Food Technology, GMO, Overview

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## I. INTRODUCTION TO FOOD SCIENCE AND ETHICS

Global food security is an increasingly urgent issue as the world's population is projected to reach 9.7 billion by 2050,<sup>1</sup> and it is estimated that food production must grow by 70% to meet this growing demand.<sup>2</sup> However, food security is threatened by a multitude of issues including food wastage, with nearly 1.3 billion tons of food lost yearly from production to retail and by consumers annually.<sup>3</sup> Moreover, economic barriers prove a hindrance to food security, particularly in low-income countries.<sup>4</sup> Food science and technology can help in addressing these issues by improving food production techniques, the addition of novel ingredients derived from sustainable sources, and development of new and acceptable food products.<sup>5</sup>

Amidst the advancement in food science and technology, there is a growing need to incorporate ethical principles to this rapidly developing field since they have a profound consequence on the society and environment. Ethics is a “*discipline concerned with what is morally good and bad and morally right and wrong*”.<sup>6</sup> Morality refers to the “*combined norms and values of an individual, group or organization*”.<sup>7</sup> The commonly applied moral theories include utilitarianism (consequence-based where rightness of an action is determined by its ability to maximize utility and happiness), deontology (duty-based where no harm is permitted, even if it results in a positive outcome), and virtue ethics (character-based where the emphasis is on what makes a person good instead of what makes a good action).<sup>8,9</sup>

The principles of bioethics include beneficence (improve or benefit people's health or broader wellbeing), non-maleficence (avoid causing harm), respect for people (including respect for autonomy and making an informed decision), and justice (ensuring people are treated fairly and equitably).<sup>10</sup>

Food ethics deals with the production, processing, distribution and consumption of food, and addresses the practices in the food system with humanity's accumulated standards and procedures for right conduct, social justice and sustainability.<sup>11</sup> In short, a moral issue in food ethics either involves food substances (what to consume and what not to consume) or the societal and environmental impacts of food production and consumption.<sup>7</sup>

Some of the current topics related to ethics being debated in the area of food science and technology are summarized below.

## II. GENETICALLY MODIFIED (GM) FOODS

The most extensively discussed ethical topic related to food science and technology is the development of genetically modified (GM) foods. Genetically modified organisms (GMOs) are organisms (including plants, animals, or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination.<sup>12</sup> Foods that are produced from or using GMOs are called GM foods.<sup>12</sup> Genome manipulation is done using recombinant deoxyribonucleic acid (rDNA) where genes from multiple genetic sources are translocated.<sup>13</sup>

Following the development of FLAVR SAVR™ tomato, the first commercially available GM crop, discussions regarding the ethical nature of GM foods began.<sup>14</sup> According

to the reports of the Nuffield Council on Bioethics (NCOB) regarding the social and ethical challenges raised by the adoption of GM crops, five concerns were listed including potential harm to human health; potential harm to the environment; negative effect on traditional farming; excessive corporate control; and the 'unnaturalness' of the technology.<sup>15</sup>

Ethical analysis of these concerns by NCOB was undertaken and in relation to the 'unnaturalness' issue, it was deemed not morally objectionable since it did not differ greatly from conventional breeding. As a part of assessing costs, benefits, and risks, the NCOB concluded that each case must be examined individually. Moreover, it was considered vital to view the potential beneficence aspect of GM crops responsibly (such as tolerance to herbicides, insect and pest resistance, bacterial, fungal and viral resistance, abiotic stress resistance, and micronutrient enrichment) since they could help reduce poverty in developing countries and improve food security.<sup>15</sup> Failing to act responsibly may deprive developing nations of the benefits of GM foods which contradicts the ethical principle of justice.<sup>15</sup>

Another ongoing discussion is related to the mandatory labeling of GM foods as they have widely penetrated the market. While it is generally accepted that consumers have the right to know what product contains GM ingredients and choose accordingly (autonomy), however, according to the Food and Drug Administration, GM foods are not significantly different from other foods, or do not pose any greater safety concerns than foods developed by traditional plant breeding techniques.<sup>14</sup> This policy may be ethically questionable since it contravenes autonomy, which here refers to providing detailed information to those seeking it.<sup>14</sup>

### III. FOOD ADDITIVES

The World Health Organization defines food additives as “the substances that are added to food to maintain or improve the safety, freshness, taste, texture, or appearance of food”.<sup>16</sup> These include flavoring agents, enzyme preparations, and other preparations such as preservatives, coloring, and sweetening agents.<sup>16</sup>

However, food additives have come under increasing scrutiny for safety as studies indicate several health concerns related to them. For instance, widely-used additives such as sodium benzoate, aspartame, tartrazine, carrageenan, and potassium benzoate have been demonstrated to have teratogenic properties,<sup>17</sup> and suggested as a trigger for hypersensitivity reactions.<sup>18</sup>

Mephram (2011), presented a deep insight into the ethical aspect of food additives from three viewpoints viz. consumer sovereignty (which refers to the consumer's autonomy and right to make an informed choice), consumer health (which relates to the adverse health effects of additives), and the rights and welfare of animals used in food safety evaluations.<sup>19</sup> From the manufacturer's perspective, additives are financially beneficial since they economize on the cost of natural ingredients and avoid the issue of limited availability, and extend the shelf life of the food.<sup>19</sup>

#### IV. NOVEL FOOD PACKAGING

In the food industry, the role of traditional packaging was mainly related to protection and preservation, containment, communication and marketing, and convenience.<sup>20</sup> The recent innovations and novelty in food packaging are largely driven by consumer preferences for mildly processed products with long shelf lives and convenience,<sup>21</sup> modern retail practices and lifestyle changes,<sup>22</sup> an increasing demand for prepared foods like microwave meals and small-sized packages,<sup>23</sup> and the increasing food-borne microbial outbreaks.<sup>24</sup> Moreover, the rising trend towards the use of environment-friendly recyclable, reusable, and compostable packing is further impelling the rise of novelty in food packaging.<sup>25</sup>

Active food packaging refers to food packaging that has a functional enhancement, such as antimicrobial, antioxidant, or biocatalytic properties through the addition of active compounds or additives contained inside polymer materials.<sup>26,27</sup> Food is protected from undesirable flavors as a result of controlled delivery of active agents into food via packaging films over extended periods of storage and distribution.<sup>28</sup> These include active agents such as antioxidants and antimicrobials, retaining compounds (ethylene, oxygen and water),<sup>29</sup> or scavengers like cyclodextrins to remove unwanted food components.<sup>30</sup>

Nonetheless, the safety of active packaging remains largely debatable owing to the toxicity profile of artificial antioxidative agents like butylated hydroxy-toluene, thioester and organophosphate compounds.<sup>31</sup>

Another type of packaging that has been developed is smart food packaging. Essentially, this is a packaging system that can perform smart functions, including detection, registration, location, communication, and application of scientific logic, thereby assisting in decision-making, extending shelf life, improving quality and safety, providing information and warning about possible issues.<sup>32</sup> Nanomaterials added to packaging react to environmental changes, repair themselves, detect the presence of contamination and/or pathogens and alert the consumer. Generally, the self-healing packaging materials contain nano/microencapsulated repair agents which release small amounts of an encapsulated "healing agent" that have been added to the polymeric coatings in response to a trigger mechanism.<sup>33</sup>

The application of nanotechnology in the food industry has made it imperative to analyze this development from an ethical perspective in order to ensure public acceptance. Imran and colleagues (2010) listed several ethical concerns related to the rise of active and smart food packaging.<sup>33</sup> Some of these include the potential for nanotechnology to deepen the gap between the rich and poor, concerns related to privacy, safety, and security given the wide availability of nano-devices, uncertainty regarding who will control the access to these devices and regulate it, and potential for nano-shells and nano-materials to accumulate and cause tissue and organ damage.<sup>33</sup>

According to Coles and Frewer (2013), the ethical principle of non-maleficence is prominent in this situation since the risks related to nanotechnology and potential adverse effects on humans and the environment are unclear.<sup>34</sup>

## V. CULTURED MEAT

Cultured or Cultivated Meat refers to animal meat that is produced by directly cultivating animal cells.<sup>35</sup> Compared to traditional meat production, this production method eliminates the need to raise and farm animals for food.<sup>36</sup> In light of the existing challenges in the meat production system related to negative environmental impact (such as emission of greenhouse gas like methane), being slaughter-free, and public health effects such as antibiotic resistance and animal-transmitted pandemics, the development and use of cultured meat is suggested as a way to reduce animal meat consumption,<sup>37-41</sup> and may fulfill the ethical principle of beneficence.

Nevertheless, as discussed by Bryant (2019), the acceptance of cultured meat has been marked with a number of ethical issues. For instance, various religious communities, including Jews, Muslims, and Hindus are concerned regarding the status of cultured meats from a religious standpoint. Cultured meat is generally considered kosher by rabbis in Judaism, while some contend the cells must be sourced from kosher-slaughtered animals. Cultured meat is considered halal (permissible) in Islam if the cells used in its production are from animals that have been slaughtered according to Islamic law. Since Hinduism preaches non-violence, some Hindu's may decide to eat cultured meat as a way of avoiding harming animals. In general, there is some indication of avoidance of cultured meat from religiously prohibited species (for example, pork in Islam and beef in Hinduism).<sup>40</sup> Since culture influences the ethical perception which in turn determines the ethical decision-making process,<sup>42</sup> the religious aspects pertaining to cultured meat must be given due consideration.

Another topic worth debating from an ethical aspect, is the possible economic implications of cultured meat. Concerns have been raised regarding the effect of cultured meat on animal farmers, the potential for food production to be consolidated under huge businesses, and how the relative pricing of cultured meat may impact inequality.<sup>43, 44</sup>

Moreover, while regulatory bodies ensure that health, nutrient content and functional claims on food labels are trustworthy in order to maintain ethical food labelling,<sup>40</sup> there is still limited clarity with regard to the regulations on cultured meat. For instance, it is unclear what type of nutritional and toxicological proof the European Food Safety Authority would require to approve cultured beef (under Novel Foods Regulation (EU) No 2015/2283). Moreover, according to prevailing regulations in the United States and the European Union, cultured meat may not be considered "meat", but their definitions may be revised to include cultured meat, particularly given the concerns around health and allergy.<sup>40</sup>

## VI. CONCLUSION

The food science and technology sector is clearly making rapid progress toward global food security, and innovations such as GM foods, food additives, novel packaging, and cultured meat have benefits that may prove particularly useful in ensuring food security in developing countries. However, ethical issues have also emerged, mainly related to safety, autonomy, equity, and religious/cultural acceptability, and it is imperative to weigh the costs/benefits and examine each innovation from an ethical lens to ensure consumer acceptance of the food. Since food labeling plays a vital role in providing relevant information to consumers about the food product, it is crucial that ethical labeling of food

items is carried out in a manner that maintains the trustworthiness of claims on food labels, the intelligibility of label information, listing of food additives on labels and labeling of genetically modified foods.<sup>45</sup>

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