About the Nutrition Value of Some Popular Meat Substitutes

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Received: February 14, 2020; Published: February 26, 2020

Abstract

To meet the requirement for food by the increasing human population, meat substitutes such as cultured meat, plant-based meat analogues, and edible insect meat are presented for consumers. This article summaries characters of these meat substitutes and compares meat substitutes with conventional meat in nutrient aspects and health benefits. Plant based meat analogues have been invented and accepted by wide customers from long time ago. It has very obvious strengthen over conventional meat, for example, it contains all necessary and rich nutrient including energy, protein, starch, fat, minerals for daily intake of human being. Some of edible insect contains higher content of valuable fatty acids such as linoleic, and linolenic acids than traditional poultry and fish. Some of insects are rich source of essential amino acids, it provides supplement amino acids for residents who cannot intake from other diets in local region. Cultured meat was presented as high protein content and production because of rapid cell proliferation in laboratory. However, some of micronutrients such as vitamin B12 and iron will have to be extra added in medium, because they cannot be synthesized in cultured meat. These meat substitutes for wider application and need for in-depth investigation are needed.

Keywords: Nutrition Value; Meat Substitutes; Cultured Meat; Edible Insect Meat

Background

Population in earth is growing rapidly every year, and it is expected to exceed 9 billion by 2050. Based on the forecast of the Food and Agriculture Organization (FAO), 70% more food will be needed to satisfy the demand of growing population. Moreover, it is well known that all food especially vegetable and meat are wasted because of short shelf-life. On the other hand, many developing countries such as India, China and Russia continue to increase animal meat consumption [1]. Therefore, the competition among livestock system, arable land, human residential become more and more severe. Developing an efficient protein production to address the global issue is very necessary. Among meat alternatives, cultured meat, plant-based meat analogues, and edible insect meat are presented as popular solutions for consumers who want to maintain their meat diet [2]. The benefits and drawbacks of each meat substitute were shown in table 1.

Cultured meat

In addition to high protein content, traditional meats provide other types of nutrition sources such as fat composites, vitamins, and minerals [3]. Their nutritional levels must be supplied and adjusted in the culture medium since they cannot be produced by muscle cells in cultured meat. For example, the ratio between polyunsaturated fatty acids, saturated fatty acids need to be balanced to avoid the risk of higher rancidity. In addition, some essential micronutrients such as vitamin B₁₂ can only be synthesized by certain gut-colonizing bacteria. Therefore, the strategy to supply vitamin B₁₂ in cultured meat is using biosynthetic microbial fermentation in an aseptic environment. Similarly, iron in the conventional meat is found as part of proteins hemoglobin and myoglobin and is presented as the bioavailable heme form [4]. In order to offering iron in a bioavailable form, heme synthesis and subsequent myoglobin synthesis need to occur by providing ferric ions bound to the plasma binding protein transferrin [5]. On the other hand, to minimize concentration of ferrous ions and free ferric in the medium, levels of transferrin must be checked closely [6]. Overall, cultured meat is a high protein re-
source, some research consider it will bring much more customers as it provides a potential diet for vegetarian. However, more research needs to be conducted to reduce nutrition loss in cultured meat in the future.

### Table 1: The benefits and drawbacks of different meat substitutes.

<table>
<thead>
<tr>
<th>Type of meat substitute</th>
<th>Benefits</th>
<th>Drawbacks</th>
</tr>
</thead>
</table>
| Cultured meat           | (1) The cultured meat is a rich source of protein.  
                          (2) The cultured meat allows more differentiated product range for consumers with food-related intolerances and allergies.  
                          (3) High meat production due to short cell proliferation | (1) Some micronutrition such as essential vitamin B₁₂ and iron cannot be produced by muscle cells in cultured meat.  
                                                                            (2) Nutritional ratio such as the ration among saturated fatty acid, poly-unsaturated fatty acids, omega-3 needs to be controlled. Otherwise, the risk of high rancidity may occur.  
                                                                            (3) For the nutrition that needs to be supplied by culture medium, the nutrition level needs to be monitored accurately to provide nutrition in a bioavailable form. |
| Plant-based meat analogues | (1) Plant-based meat analogues contains less saturated fat content than meat.  
                              (2) Similar type and content of nutrient as real meat | (1) Beef presents a haem iron, while plants such soybean, wheat, and pea include iron in the form of non-haem, people need to consume vitamin C food to enhance absorption of iron. |
| Edible insects          | (1) Some insects contain more essential amino acids when comparing with plants.  
                          (2) Important micronutrients such as iron and zinc are rich in some insects  
                          (3) Some insects can improve immunity effects for human. | (1) Edible insects generally contain less fat content than conventional meats. |

### Plant-based meat analogues

In addition to traditional meat analogues such as tofu and tempeh from Asia for centuries, the meat analogues also produced by cooking extrusion of plant products such as soybean, wheat, and pea [7]. After the heating process, the plant-based meat analogues presented weak aroma, tasteless, and the texture simulated to meat. Then special flavor of ingredients will be added to mimic meat flavor (i.e. chicken and beef flavor). Table 2 shows a comparison of nutrition profiles between plant-based meat analogues and beef. Regarding the fat content, there is quite different among these products. Arrum consists of very low amounts of fat. However, significantly lower saturated fat content was observed in pea than beef, saturated fat content in beef is 1.9g per 100g, while is 0.15 in Arrum [8]. Plant-based meat analogue provides a rich source of carbohydrate in the forms of starch and NSP. In contrast, beef does not contain carbohydrate. Beef and Plant-based meat analogues have similar amount of energy except for Arrum. This is probably due to the dry weight is used for Arrum. For the iron content, all of products contain similar level. However, beef presents a haem iron, while plant includes iron in the form of non-haem. In summary, Plant-based meat analogues maybe healthy, convenient, sustainable, and animal friendly meat alternatives.

### Table 2: Comparison of nutrition profiles between plant-based meat analogues and beef (100g).

<table>
<thead>
<tr>
<th>Food Type</th>
<th>Energy (kcal)</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Starch</th>
<th>NSP*</th>
<th>Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef-raw</td>
<td>123</td>
<td>20.3</td>
<td>4.6</td>
<td>0</td>
<td>0</td>
<td>2.1</td>
</tr>
<tr>
<td>Soybeans (Tempeh)-raw</td>
<td>166</td>
<td>20.7</td>
<td>6.4</td>
<td>4.6</td>
<td>4.3</td>
<td>3.6</td>
</tr>
<tr>
<td>Wheat (Trivalli)-raw</td>
<td>127</td>
<td>17.0</td>
<td>5.0</td>
<td>1.5</td>
<td>5.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Pea (Arrum)-dry</td>
<td>345</td>
<td>26.0</td>
<td>1.4</td>
<td>-</td>
<td>2.5</td>
<td>-</td>
</tr>
</tbody>
</table>

*Non-starch polysaccharides.

Citation: Dr. Dongjie Chen. “About the Nutrition Value of Some Popular Meat Substitutes”. EC Nutrition SI.02 (2020): 01–03.
Edible insects

The type of edible insects recorded in publications is more than 1900, and the nutritional values and composition are highly variable. Among them, four popular edible insect species including Imbrasia belina, Rhynchophorus phoenicis, Oryctes rhinoceros and Macrotermes bellicosus showed they contained all essential amino acids. In particular, three essential amino acids including lysine, threonine, and methionine are limited in plants such as cereal and legume [9]. Therefore, the edible insect can be used as nutrition supplements for local residents for their protein resource. For instance, in Nigeria, cereals contain very limited amount of lysine amino acids, the termite M. bellicosus can be used as a source of this amino acid. Moreover, residents in Papua New Guinea consume foods such as taro, yam, and sweet potato which are limited in lysine and leucine, this amino acid can be obtained from a larvae called Rhynchophorus bilineatus. With respect to fat content of edible insects, the highest values are found in termites and palm weevil larvae [10]. Although these insects contain less saturated/unsaturated fatty acid ratio than poultry and fish, they have higher content of polyunsaturates, linoleic, and linolenic acids. In addition to that, insects also are rich resource of important micronutrients such as iron and zinc, because these micronutrient deficiencies in children and women of reproductive age in developing countries.

Conclusion

In summary, three meat substitutes have benefits and drawbacks compared with the traditional meat. Cultured meat exhibited high protein content and production due to short cell cycle. Some edible insects contain all essential amino acids which are required by human. Some specific insects also contain higher content of polyunsaturates, linoleic, and linolenic acids than traditional meat such as poultry and fish. Plant-based meat analogues have less content of saturated fatty acids than traditional meat; higher carbohydrate in the forms of starch and NSP than traditional meat. Plant based meat analogues start from several centuries. It has already been accepted by large population. In contrast, cultured meat and food insects are relatively novel meat surrogates, and therefore, many practical issues in terms of customer perception and acceptance, ethics, food safety, and environmental impact need to be addressed before wide application.

Bibliography


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