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# Proximate Composition and Sensory Preference of Beef Sausages with Unripe Jackfruit

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**Abstract**— Underutilization of jackfruit and demand for healthier meat product with nutritional benefits and similar taste to meat had led to this study which to evaluate the proximate composition, and consumer preference of beef sausage with different ratio of unripe jackfruit. Five formulations of beef sausage were prepared with different amount of beef to unripe jackfruit were: Control (65:0), A (48.75:16.26), B (32.5:32.5), C (16.25:48.75), and D (0:65). Results found that carbohydrate contents of beef sausage with unripe jackfruit were higher ( $P>0.05$ ) than in control sausage but were lower ( $P>0.05$ ) in protein, fat, and fibre content. However, results found that all sausages with unripe jackfruit were found significantly higher ( $P<0.05$ ) in moisture content, and ash compared to control beef sausage. As expected, hedonic test found that consumers preferred ( $P<0.05$ ) control beef sausage compared to other formulations. Beef sausage incorporated with 25% unripe jackfruit (formulation A) was the most preferred by consumers in texture, taste, and overall acceptance among all sausages with unripe jackfruit. These findings obtained that formulation of beef sausage incorporated with unripe jackfruit could be accepted by consumers.

**Keywords**— Beef sausage; Nutritious sausage; Jackfruit sausage; Sausage preference

## I. INTRODUCTION

Sausage is defined as ground or chopped meat mixed with salt, seasonings, and other ingredients such as starch and oil which can be stuffed into a container or casing of particular shape and size. According to Abdolghafour and Saghir [1], sausages can be grouped into five types depending on preparation types which are fresh sausage, fermented sausage, smoked precooked sausage, emulsion-type sausage, and cooked sausage. Sausages contain high amount of protein but

also high in fats which mostly in the form of saturated and unsaturated fats which contribute to calories [2]. In beef sausages, the protein and fat content ranged from 10.63 to 16.43%, and 1.1 and to 12.22%, respectively [3].

Meat analogue, also known as meat substitute, mock meat, faux meat or imitation meat is a meat replacer in a diet whereby it has a structure that is similar to meat but it is different in composition. In fact, soybean, mushrooms, legumes, wheat, rye and barley are the major non-meat

protein sources suitable for meat analogue. These non-meat proteins are usually added with flavouring in order to produce products that taste like meat [4]. In meat product, meat analogues are created because of some believers are prohibited from eating meat like Buddhists and Hindus [5], awareness of health as animal-based diets are one of the contributors towards heart disease and cancers as they consist of high cholesterol and saturated fat [2], and vegetarian concern which belief that animal rights as it is wrong to kill animals and environmental factor as meat production would affect the environment [2, 5].

Usually the main component of plant-based protein that can be applied in beef sausage include glutens, globulins, and soy proteins like tofu or tempeh [6]. Textured vegetable protein is widely used in sausage production as it gives meat fibrous structure similar to meat and flavour. Jackfruit or scientifically known as *Artocarpus heterophyllus* is a species of mulberry family is one of the abundance local fruits that can be easily found in Malaysia [7]. Unfortunately, the fruit is underutilized and not classified as commercial crops due to the short shelf life and insufficient processing facilities in the regions where the fruits are grown [8].

Although the protein content of unripe jackfruit is approximately lower (1.45%) [9] than protein content in beef meat (20.97 to 21.17%) [10], however, the flesh texture of unripe jackfruit is smooth and have similar texture to meat and tasteless. The flesh is able to absorb added flavourings like spice to imitate the meaty flavour [11]. Furthermore, the unripe jackfruit rich in various vitamins and minerals, especially high in ascorbic acid [9]. Thus, the objectives of this study were to evaluate the proximate composition of beef sausage formulated with unripe jackfruit, and to evaluate the consumer preference of the sausages.

## II. MATERIALS AND METHODS

### A. Preparation of Beef Sausages

There were five formulations of sausages prepared with different percentage of beef to unripe jackfruit which are; control (100% ground beef without unripe jackfruit), B (75% ground beef and 25%), C (50% ground beef and 50% jackfruit), D (25% ground beef and 75% jackfruit), and E (100% unripe jackfruit without ground beef). Salt (1%) was dissolved in cold water (9%) by blending in a food processor (MK-5087M, Panasonic, Malaysia) for 10 s, before mixing with the ground beef/jackfruit mixture for another 10 s.

Then, other ingredients [soy protein isolate (6.4%), texturized vegetable protein (6%), vegetable oil (4.4%), potato starch (6%), seasonings (2%), and sodium tripolyphosphate (0.2%)] were added and blend together. All the ingredients were left to blend with a total of 110 seconds. Next, the batter was stuffed into cellulose casings using a hand operated stuffer and it was tied into 8 cm long sausage before cooking in an oven at 180°C for 15 minutes. Finally, the sausages were then immersed in cold water (6 °C) for 5 minutes before removing the casings and kept in frozen condition before analysis.

### B. Determination of Proximate Composition

Moisture analyser (MX-50, A&D Company Limited, Japan) was used to determine the moisture content of the sausages while ash content was carried out using dry ashing method with incineration in the muffle furnace (Carbolite, England) at 550°C. Protein were determined using Kjeldahl apparatus (BUCHI, Switzerland). Fat analysis was done using Automatic Soxhlet extraction method (Soxhterm® extractor, Gerhardt). Crude fibre was determined according to Gerhardt method using Fibretherm (Gerhardt GmbH, German). Finally, the carbohydrate content of all sausages was calculated by totaling up the percentage of moisture, ash, protein, and fat, followed by deducting the result from 100%. All analysis were done according to AOAC [12] method.

### C. Determination Physical Properties of Beef Sausages

Hardness and springiness of sausages were carried out using Texture Analyzer TA.XT Plus (Stable Micro System, Surrey, London) with 5 mm diameter spherical probe (P/5S). Colour of the sausages was analysed using colorimeter (LabScan®XE Spectrophotometer Model, HunterLab) based on L\*a\*b\* colour scale system.

### D. Determination of Sensory Preference of Beef Sausages

Determination of preference of sausages was done using 7-point Hedonic test according to Meilgaard et al. [13] which the scale ranging from 1 (extremely dislike) to 7 (like extremely). The sensory evaluation was performed by 76 untrained panellists from Faculty of Science and Technology, Universiti Sains Islam Malaysia, Negeri Sembilan, Malaysia. All panellists were served with three-random digit coded number samples of sausages to avoid bias. Each of the panellist was asked to evaluate the aroma, colour, texture, taste, and overall acceptance of sausages in an individual booth.

### E. Statistical Analysis

All data were analysed with one-way analysis of variance or ANOVA, followed by Tukey's test to compare the means between samples. Data was analysed using Minitab® software, Release 16 [14] and the statistical significance was established at ( $P < 0.05$ ). All experiments were replicated in twice.

Table 1. Proximate composition of beef sausages incorporated with unripe jackfruit compared to control beef sausage.

Proximate Composition	Control	A	B	C	D
Moisture	57.81 <sup>c</sup>	59.28 <sup>c</sup>	62.20 <sup>bc</sup>	65.67 <sup>ab</sup>	68.72 <sup>a</sup>
Ash	2.41 <sup>b</sup>	2.39 <sup>b</sup>	2.64 <sup>ab</sup>	2.67 <sup>ab</sup>	2.78 <sup>a</sup>
Protein	20.54 <sup>a</sup>	16.74 <sup>ab</sup>	15.52 <sup>ab</sup>	12.78 <sup>ab</sup>	10.47 <sup>b</sup>
Fat	9.31 <sup>a</sup>	7.84 <sup>a</sup>	8.05 <sup>a</sup>	5.89 <sup>a</sup>	3.81 <sup>a</sup>
Carbohydrate	9.94 <sup>a</sup>	13.77 <sup>a</sup>	11.59 <sup>a</sup>	13.00 <sup>a</sup>	14.23 <sup>a</sup>
Fibre	4.54 <sup>a</sup>	3.94 <sup>a</sup>	3.32 <sup>a</sup>	4.41 <sup>a</sup>	4.44 <sup>a</sup>

Notes:

- Different alphabetical letters within rows indicate significance different ( $P < 0.05$ ) among beef sausage samples. All data were replicated in twice.
- Control= 100% ground beef; A= 25% unripe jackfruit and 75% ground beef; B= 50% unripe jackfruit and 50% ground beef; C= 75% unripe jackfruit and 25% ground beef; D= 100% unripe jackfruit

### III. RESULTS AND DISCUSSION

#### A. Proximate Composition of Sausages

The proximate composition of the sausages are shown in Table 1. Results found that the increment of unripe jackfruit in beef sausage formulations were significantly ( $P < 0.05$ ) increased moisture, and ash contents of sausages but consistently decreased protein and fat contents of the sausages. However, incorporation of unripe jackfruit in beef sausage did not change ( $P > 0.05$ ) fibre content of sausages.

The moisture content of beef sausages incorporated with unripe jackfruit were higher than control beef sausage might be due to high moisture content of unripe jackfruit (Table 1) which ranged from 76.20 to 85.0% [15]. A previous study was also reported that meat patties with jackfruit contain higher moisture than without addition of jackfruit [11]. As expected, increment of unripe jackfruit in beef sausage consistently increased ash content (Table 1) and was in line with previous study [11]. However, protein content of control beef sausage was the highest ( $P < 0.05$ ) compared to formulation with unripe jackfruit and was also in agreement with previous study [11]. The protein in control beef sausage was necessarily from beef meat. The fat content of control beef sausage was the highest ( $P > 0.05$ ) and was due to the fat from beef content. Indeed, a previous study reported that the fat content of unripe jackfruit ranged from 0.01 to 0.06% [16].

Evaluation of carbohydrate content found that the lowest (9.94%) carbohydrate content was shown in control beef sausage as expected since beef meat considered did not contain carbohydrate and the content in the beef sausage was mainly contributed by potato starch. Carbohydrate content of unripe jackfruit was between 9.4 and 23.5% [15-16]. The fibre content of beef sausages ranged between 3.32 and 4.54%. Control beef sausage contained the highest fibre content while beef sausage incorporated with 50% jackfruit obtained the lowest fibre content. The decrement of fibre in beef sausage incorporated with unripe could be due to the

heat treatment through boiling which can degrade fibre especially the soluble fibre in unripe jackfruit. Total dietary fibre in apple, corn, and oat bran degraded after autoclaving at 100°C for 30 minutes and 121°C for 15 minutes [17].

#### B. Physical Properties of Sausages

The physical properties of sausages are shown in Table 2. Results found that the incorporated unripe jackfruit in beef sausage formulations did not affect significantly ( $P > 0.05$ ) the hardness and springiness of sausages. However, incorporated unripe jackfruit in beef sausage formulations slightly increased ( $P > 0.05$ ) the hardness of beef sausage and slightly decreased ( $P > 0.05$ ) the sausage springiness. In fact, the improvement of textural properties was associated to replacement of fat with different fibres [18].

Colour of sausages was also shown in Table 2. Incorporated unripe jackfruit in beef sausage affects the redness ( $P < 0.05$ ) of sausage but not in lightness and yellowish colour of sausages. The highest ( $P < 0.05$ ) redness colour of sausage was obtained in unripe jackfruit sausage (formulation D) and this might be due to the carotene content pigment that provide red-yellowish colour in unripe jackfruit. According to Ubi et al. [9], the carotene content in unripe jackfruit was 40 µg which is equivalent with vitamin A content.

#### C. Consumer Preference of Sausages

Table 3 shows consumer preference of beef sausage incorporated with different percentage of unripe jackfruit. As expected, results found that the control beef sausage obtained the highest ( $P < 0.05$ ) mean scores for attributes colour, aroma, taste, and overall acceptance which are 5.88, 6.88, 6.76, and 6.90, respectively. However, in attribute texture the highest mean score was obtained in beef sausage A which was formulated with 75% beef and 25% unripe jackfruit which was similar ( $P > 0.05$ ) to control and beef sausage B.

Table 2. Physical properties of beef sausages incorporated with unripe jackfruit compared to control beef sausage.

Physical Properties	Control	A	B	C	D
Hardness	4.84 <sup>a</sup>	5.27 <sup>a</sup>	6.06 <sup>a</sup>	5.81 <sup>a</sup>	5.87 <sup>a</sup>
Springiness	1.79 <sup>a</sup>	0.99 <sup>a</sup>	0.99 <sup>a</sup>	0.97 <sup>a</sup>	0.93 <sup>a</sup>
Lightness ( <i>L</i> *)	45.10 <sup>a</sup>	44.86 <sup>a</sup>	45.03 <sup>a</sup>	46.37 <sup>a</sup>	46.65 <sup>a</sup>
Redness ( <i>a</i> *)	3.31 <sup>b</sup>	3.20 <sup>b</sup>	3.09 <sup>b</sup>	3.65 <sup>b</sup>	5.00 <sup>a</sup>
Yellowness ( <i>b</i> *)	12.94 <sup>a</sup>	12.66 <sup>a</sup>	11.92 <sup>a</sup>	11.84 <sup>a</sup>	14.18 <sup>a</sup>

Notes:

- Different alphabetical letters within rows indicate significance different ( $P < 0.05$ ) among beef sausage samples. All data were replicated in twice.
- Control= 100% ground beef; A= 25% unripe jackfruit and 75% ground beef; B= 50% unripe jackfruit and 50% ground beef; C= 75% unripe jackfruit and 25% ground beef; D= 100% unripe jackfruit

Table 3. Consumer preference of beef sausages incorporated with unripe jackfruit compared to control beef sausage.

Consumer Preference	Control	A	B	C	D
Colour	5.88 <sup>a</sup>	5.80 <sup>a</sup>	5.86 <sup>a</sup>	5.32 <sup>ab</sup>	5.03 <sup>b</sup>
Aroma	6.88 <sup>a</sup>	6.50 <sup>ab</sup>	6.61 <sup>ab</sup>	5.88 <sup>bc</sup>	5.37 <sup>c</sup>
Texture	6.46 <sup>a</sup>	6.55 <sup>a</sup>	6.45 <sup>a</sup>	4.61 <sup>b</sup>	3.58 <sup>c</sup>
Taste	6.76 <sup>a</sup>	6.67 <sup>a</sup>	6.49 <sup>a</sup>	5.03 <sup>b</sup>	3.84 <sup>c</sup>
Overall Acceptance	6.90 <sup>a</sup>	6.65 <sup>a</sup>	6.51 <sup>a</sup>	5.16 <sup>b</sup>	4.04 <sup>c</sup>

Notes:

- Different alphabetical letters within rows indicate significance different ( $P < 0.05$ ) among beef sausage samples. All data were replicated in twice.
- Control= 100% ground beef; A= 25% unripe jackfruit and 75% ground beef; B= 50% unripe jackfruit and 50% ground beef; C= 75% unripe jackfruit and 25% ground beef; D= 100% unripe jackfruit

The colour of sausages was ranged between 5.03 and 5.88 and found that the likeability of colour decreased when increasing the unripe jackfruit. This could be due to the red colour of beef meat which contained myoglobin that attracted the panelists [19]. Results also obtained that higher percentage of unripe jackfruit incorporated in beef sausages decreased ( $P < 0.05$ ) consumer's acceptance. The acceptability was comparable to the control sample up to the 75% of jackfruit incorporation. According to Sharima-Abdullah [20], colour acceptability of imitation chicken nuggets by panellists decreased significantly ( $P < 0.05$ ) with the increasing of TVP.

Aroma of control beef sausage was the highest ( $P < 0.05$ ) compared to other beef sausages. The aroma was ranged between 6.88 and 5.37 which mean the panelists were either neither like nor dislike or like slightly. Aroma of control beef sausage was the highest ( $P < 0.05$ ) compared to other beef sausages. The aroma was ranged between 5.37 and 6.88 which indicate the panelists were either neither like nor dislike or like slightly the sausage aroma. In fact, a previous study also reported that the aroma of control meat patties was not significantly higher ( $P > 0.05$ ) than meat patties incorporated with unripe jackfruit which indicated that the presence of jackfruit did not influence the aroma of meat patties [11].

Texture of sausage found a decreased of likeability with the increasing of percentage of unripe jackfruit ( $P < 0.05$ ). Previously, 25% and 50% substitution level of jackfruit obtained the highest mean score than other meat patties. It could be assumed that the incorporation of jackfruit would affect the texture if it was in large amount as it had high moisture content [11].

In the context of taste, it was found that the panelists most preferred the taste of control beef sausage than other sausages. The mean scores of taste were ranged between 3.84 and 6.76. This finding was in line with Huda et al. [21] where the increasing levels of apple pomace had decreased the flavour scores of mutton nuggets ( $P < 0.05$ ). Results also found that consumers' overall acceptance was the highest in control beef sausage ( $P > 0.05$ ). It was also found that the overall acceptance of sausage was comparable to the control up to 50% incorporation of unripe jackfruit.

#### IV. CONCLUSIONS

This study concluded that beef sausages incorporated with unripe jackfruit are high in moisture and ash content but lower in protein, fat and fibre compared to control beef sausage. The control sausage was found the highest in redness compared than other sausages. Incorporation unripe jackfruit in sausage did not affect the texture of beef sausages which include the attributes of hardness, springiness, cohesiveness, and chewiness. However, sensory test indicated that consumers preferred control beef sausage compared to other formulations.

#### CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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