Effect of Soybean and Finger Millet Flours on the Physicochemical and Sensory Quality of Beef Meat Sausage

B. Behailu¹ and M. Abebe¹

¹Department of Food Engineering Program, Bahir Dar Institute of Technology, P.o.Box 26, Bahir Dar, Ethiopia.

Authors’ contributions

This work was carried out in collaboration between both authors. Author MA conceived the idea, designed study objectives, methods, managed the raw material collections and assisted critically reviewed the manuscript. Author BB managed the statistical data analyses, data interpretation and drafted the manuscript. Both authors read and approved the final manuscript.

Article Information

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(1) Dr. Md. Zakir Hossen, Professor, Department of Agricultural Chemistry, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh- 2202; Bangladesh.

(2) Prof. Pradip K. Bhowmik, Department of Chemistry, University of Nevada, Las Vegas, 4505 Maryland Parkway, Las Vegas NV 89154-4003, USA.

(3) Olaniyi Olawale, Ojuko, University of Ibadan, Nigeria.

ABSTRACT

Aims: Nowadays increasing costs of animal protein has necessitated the need to investigate uses of cheaper and nutritive alternatives various food formulations. To increase nutritional value and sensory qualities of sausage from soybean and finger millet flours and beef meat and to reduce the formulation costs of the product.

Study Design: The experiment was set in single factor experiments. Blending ratio (soy-millet flour and beef meat ratios of 10:90, 20:80, 30:70 and 0:100%) with four levels and triplicate. blend proportion of soybean and finger millet flours is similar.

Place and Duration of Study: Sample preparation, product processing and quality analysis was carried out in Bahir Dar institute of technology, Department of Food Engineering, Bahir Dar, Ethiopia between April 2017 and June 2018.

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*Corresponding author: E-mail: behailu2005bdu@gmail.com;
Methodology: Four batches of beef sausages were investigated in which finger millet and soy flours were substituted with beef meat. Proximate composition with selected mineral contents, sensory characteristics, physical properties and production cost of sausages were determined. Percentage proximate composition were determined by using the standard methods of Association of Official Analytical Chemists (AOAC). Calcium and zinc were analyzed by EDTA titration and Modified AOAC respectively and physical property of sausage were also analyzed.

Results: As soy and finger millet flours inclusion increase, the nutritional value of sausage increased such as moisture, crude protein, crude fat, crude fibre, crude ash and the cooking yield from 56.91(control) to 77.24% (30% inclusion) by reducing weight loss. The sausage products were generally accepted and 20% soy and millet flour inclusion was “liked very much. Soy and finger millet flour inclusion reduced production cost from 177 (control) to 142 ETB (30% inclusion) per mix (1150 g).

Conclusion: Soybean and finger millet flours were used in beef sausage products to improve nutritional value, consumer acceptability and reduce the formulation cost. These results suggest that beef meat can be used successfully for the production of beef meat sausage as an alternative uses of different flours.

Keywords: Soy flour; finger millet flour; sausage; physicochemical quality; sensory qualities.

1. INTRODUCTION

The food science is the transformation of raw materials into healthy food products within biophysical and socio-cultural contexts which results in production, processing, distribution, preparation and consumption of food [1]. As the world population continues to grow, various governments are confronted with the serious challenge of meeting the complex food needs of societies faced with short supply of animal protein [2]. Sausages are one of the oldest forms of meat processing and modern sausage technology has its roots deeply embedded in history.

Sausages are products in which fresh comminute meats are modified by various processing methods to yield desirable organoleptic and keeping properties. A sausage is a food usually made from ground meat, often pork, beef or veal, along with salt, spices and then stuffing into a container or casing [3]. Traditionally, sausage casings were made of the cleaned intestines or stomachs in the case of haggis and other traditional puddings. Today, however, natural casings are often replaced by collagen, cellulose, or even plastic casings, especially in the case of industrially manufactured sausages. Some forms of sausage, such as sliced sausage are prepared without a casing [4].

Functional meat products either possess nutritional ingredients that improve health or contain lesser quantity of harmful compounds like cholesterol, fat and these products are generally produced by reformulation of meat by incorporating health producing ingredients like variety of fibers, protein, polyunsaturated fatty acids (PUFA), antioxidants etc [5]. Protein is one of the major nutrients in diets needed by the human body. Since soy bean is a rich and cheaper source of plant protein, increasing research into its production and utilization would ensure a steady avenue for providing the much needed cheap but balanced protein. This would meet the teething challenges of declining protein availability in the form of soy-based food; such as soy meat combination in the form of soy meatball [2].

When soy protein is added to the products; the protein content increases there by increasing the nutritional value and reducing the expansion and hardness of the product [5]. Health benefits of soy in meat include prevention of heart diseases, cancer, high blood pressure, diabetes-related disease and many others [6,7]. Soybean oil is rich in fatty acids and devoid of cholesterol. It is an excellent source of calcium, iron, and vitamins such as niacin, thiamin and riboflavin. Soy contains all essential amino acid apart from methionine and tryptophan. These amino acids closely match those required for humans [2]. Soy-meat may also help with menopause symptoms and osteoporosis. Soybean contains an impressive array of phytochemicals (biologically active components derived from plants) which are beneficial to human nutrition [8].

Although finger millet (*Eleusine coracana*) is the conventional flour used as fillers in sausage production so as to reduce the formulation cost...
and there are various other materials that have good water holding or meat binding properties, especially cereals such as rice, corn, millet and wheat [9]. Nutritionally, finger millet is good source of nutrients especially of calcium, other minerals and fibre but the mineral composition of finger millet grains is highly variable [10].

The objective of this study was to investigate the effect of soybean and finger millet flours on the physicochemical and sensory quality of beef meat sausage.

2. MATERIALS AND METHODS

2.1 Sample Collection

Mechanically deboned beef meat was bought and immediately placed in the refrigerator prior to processing. Other materials, including salt, sugar, pepper, and other condiments were bought from the local market of Bahir Dar town, Ethiopia. Soybean (Glycine max) and finger millet (Eleusine coracana) were collected from Adet Agricultural Research Centers in Bahir Dar, Ethiopia.

2.2 Sample Preparation

Raw soybean and millet was prepared by using the method of Bouchenak [6]. They were cleaned manually to remove undesirable materials and soybean roasted at 100°C for 15 min and then decorticated by using decorticator (Germany: model: 3SX/3M) to remove the outer cover (husk) of the decorticated bean. The garlic and onion were peel manually and dried by drying oven (ZZKD: Model: DHG-9140) at 60°C for 30 h. The dried garlic, onion, soybean and millet were ground using a laboratory grinder (Master Kitchen: Model: NM-8300) and finally screened to 500 µm sieve size.

2.3 Experimental Design

The experiment was set as single factor experiments involving one factor which was blending ratio with four levels and triplicate. These are soy-millet flour and beef meat blending ratios of 10:90, 20:80, 30:70 and control 0:100%. The blend proportion of soy and finger millet flour was similar.

2.4 Sausage Processing

The meat was grounded using meat grinder Turkish Standards Institution (TSE) No. 980 sausage Production Standard (spain: Model: PM-98). The beef fat percentage should not be more than 10% of the final product [11]. The all measurable amounts of raw materials such as ground meat, soy flour, finger millet flour and spices were blended with its appropriate ratios and mixed uniformly within five minutes. The appropriate formulation ratio for preparing beef sausage was shown in Table 1 and mix uniformly within 5 min. The formulations were prepared with 0% soy and finger millet flours and 10, 20, and 30% soy flour with a constant amount of millet flour (40 g) per mix in 1,150 g. The other spices were added to the mix in constant amount.

The mixed dough was filled / stuffed into casings by vertical sausage filler (Italy: Model: TA58D) and inserted in boiling water to reduce wrinkles. The sausages were cooked at 90°C with oven (ZZKD: Model: DHG-9140) for 60 mun. After cooking, the sausages were cooled at 10°C for 10 min. Moisture on the surface of the processed sausage was removed by passage through a dryer (hot-air blowing). The final cooled sausage product in their casings was packaged in polyethylene bag prior to being analyzed.

2.5 Proximate Compositions

The proximate composition of the processed sausage product such as moisture, crude protein, crude fat, crude fiber and ash were determined by using the standard methods of (AOAC) [12]. Total carbohydrates (CHO) including fiber was determined by difference that was by subtracting the sum of the percentages of moisture (M), protein, lipid and ash content from 100. The mineral content such as calcium and zinc was analyzed by EDTA titration and Modified AOAC 960.39 respectively.

2.6 Physical Property Analysis

Physical property of sausage product such as cooking yield, cooking loss, moisture retention, fat retention and juiciness were analyzed. Cooking yield was determined by measuring the difference in the sample weight before and after cooking [13]:

\[
\text{Cooking yield (\%)} = \frac{(\text{Weight of cooked Sausage} - \text{Weight of uncooked Sausage})}{\text{Weight of uncooked Sausage}} \times 100
\]  

(1)

Cooking loss was determined the measuring the difference in the uncooked sample weight and cooked sample [9].
Cooking loss (%) = (Weight of uncooked Sausage - Weight of cooked Sausage / Weight of uncooked Sausage) * 100  (2)

Moisture retention (Mr) value represents the amount of moisture retained in the cooked product per 100 g of sample [14]

Mr (%) = (% cooked yield * moisture in cooked sausage) / 100  (3)

The extracted juice (Juiciness) was determined [15] the sausage sample was taken from the center and was cut into 2.5 mm pieces with a knife. A sample was placed between two pieces of pre-weighed Whatman (No. 41) filter paper, covered with aluminum foil and pressed for 5 min by 10 kg of force. The residue was removed and the filter paper was weighed.

Juiciness (%) = ((Weight of filter paper after pressing -Weight of filter paper before pressing) / Weight of sample)*100  (4)

Fat retention (Fr) was calculated [16].

Fr (%) = (Weight of cooked sausage * Fat content in cooked Sausage) / (Weight of uncooked sausage* Fat content in uncooked Sausage)*100  (5)

2.7 Sensory Evaluation

Sensory evaluation of sausage was evaluated and/or conducted using sensory panelists. Samples were coded and present to a 30 semi-trained sensory panel judges to evaluated samples according to degree of likeness in respect to appearance, taste, flavor, color and overall acceptability. Panelists were served in their separated locations far away from the sample cooking and preparation room and samples were coded to reduce bias. Water and cracker sausage were served in between samples assessment to enable panelists rinse properly and neutralize carryover flavors in their mouth. A 7-point hedonic scale having 7 (like extremely) as the highest score and 1 (dislike extremely) as the lowest score was used [17].

2.8 Statistical Data Analysis

Triplicate data collected for physicochemical and sensory qualities of sausage samples was subjected to Analysis of Variance (ANOVA) with appropriate Statistical Data Analysis Software. Analysis of variance (ANOVA) was carried out using SAS version 9.1.3 program.

3. RESULTS AND DISCUSSION

3.1 Chemical Composition of Sausage Product

Mix formulation of beef meat sausage product was presented in Table 1. According to Malaysian Food Regulations [16], the amount of actual meat in manufactured meat products like sausages should not be less than 65%. As a major ingredient in sausage the percentage of meat used in the formulations in this study were within the permissible limit that is the minimum percentage of meat was 70%. The proximate and selected mineral compositions of sausage products were presented in Table 2. The sausage product had moisture, ash, crude fat, crude protein, total carbohydrate and crude fiber content ranging from 58.91% - 60.53%, 4.56 - 4.69%, 6.12 - 9.36%, 21.57 - 25.10%, 4.32 - 8.84% and 0.15 - 3.43% respectively.

Table 1. Mix formulation of sausage product

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Treatments</th>
<th>0/100</th>
<th>10/90</th>
<th>20/80</th>
<th>30/70</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Meat</td>
<td>1,040</td>
<td>900</td>
<td>800</td>
<td>700</td>
<td>3440</td>
<td></td>
</tr>
<tr>
<td>Soy flour</td>
<td>0</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Millet flour</td>
<td>0</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>water</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>pepper</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>salt</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>garlic</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Onion powder</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Ginger</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1150g</td>
<td>1150g</td>
<td>1150g</td>
<td>1150g</td>
<td>4600g</td>
<td></td>
</tr>
</tbody>
</table>

When the treatment factor effect was found significant, indicated by a significant F-test (P=.05) differences between the respective means is determined using least significant difference (LSD) and considered significant when P=.05. Mean ± standard deviation of mean is used.
The soy flour is rich source of crude protein, crude fat, ash and crude fiber content compared with others. Protein, fat and fibre were increased significantly (P=.05). When soy protein is added to the products the protein content is increases there by increasing the nutritional value and reducing the expansion and hardness of the product [5]. The finger millet flour had better sources of minerals like iron and zinc. Although, finger millet is the conventional flour used as fillers in sausage production, so as to reduce the formulation cost [9].

The ash content increased due to incremental of soy inclusion because the soya and finger millet flour are better source of ash than beef beet [18]. The sausage using 30% soya flour inclusion had the highest ash content (4.69%) and estimates of ash in samples containing soy flour may be due to stored waste products in plants. It is known that plants do not have the ability to dispose of waste materials, instead they are stored as harmless materials in some parts of the plant which could be the seed and consequently the ash content of the full fat soy flour is high [2]. Cooking of sausage had increased the ash, crude fat and crude protein content and decreased the moisture content on a percentage basis in all formulations due to removal of moisture from the product [19]. On the other the increments of crude protein, crude fat, crude fiber and ash content in sausage product were due to a result of cooking losses [19]. Meat products that contain dietary fibers are excellent meat substitutes due to their inherent functional and nutritional effects [5]. Besides health benefit effects, dietary fiber suplementsations increase the bulk and prevent cooking loss in meat products with no or fewer changes in textural parameters by enhancing water binding capabilities and carries great economic advantages for both the consumers and processors [5]. The fat emulsion at 30% soy and finger millet flours inclusion being the highest fat content may be attributed to the binding of free fat (fat absorption) by soy proteins [2].

The selected mineral contents (Ca and Zn) increased significantly (P=.05) as the level of soybean and millet flours inclusion increased presented in Table 2. The maximum Ca content was recorded using 30% soya flour 1.87 mg*g\(^{-1}\) and for Zn using 30% soya and finger millet flour had the value of 0.09 mg*g\(^{-1}\). Ca and Zn content were increasing with inclusion label of flours. The increment of such minerals might be from the better sources of raw materials like finger millet.

### 3.2 Physical Properties of Sausage Product

The results of effects of varying soy and millet flour inclusions on weight loss and yield parameters are as shown in Table 3. Cooking characteristics of beef sausage are the most important factors for the meat industry in predicting the behavior of products during cooking due to non-meat ingredients or other factors. The sausage tends to shrink during the cooking process due to the denaturation of the meat proteins, with the losses of water and fat also contributing to the shrinking process [20].

The highest and lowest weight loss was recorded at 0% (43.09%) and 30% (22.75%) inclusion level resulting to an increased in yield from 56.91- 77.24% respectively. The significant increase in cooking yield up to 26% soy concentration in his study using ground beef meat [21]. In this study there were significant differences (P=.05) the weight loss and cooking yield between the treatments up to 30% soy flour concentration. Cooking yield represents the retention of water and solutes during processing.

### Table 2. Chemical composition of sausage product

<table>
<thead>
<tr>
<th>Treatment</th>
<th>SM (0%)</th>
<th>SM (10%)</th>
<th>SM (20%)</th>
<th>SM (30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>58.9±0.51bc</td>
<td>58.99±0.60ab</td>
<td>59.12±0.15a</td>
<td>60.53±0.02a</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>4.56±0.01a</td>
<td>4.58±1.04a</td>
<td>4.65±0.01a</td>
<td>4.69±0.05a</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>6.12±0.56c</td>
<td>6.75±0.01c</td>
<td>7.49±0.63b</td>
<td>9.36±0.85a</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>21.57±0.12d</td>
<td>22.05±0.01c</td>
<td>23.89±0.01b</td>
<td>25.10±0.64a</td>
</tr>
<tr>
<td>Total CHO (%)</td>
<td>8.84±0.24a</td>
<td>7.63±1.67b</td>
<td>4.85±0.78c</td>
<td>0.32±1.27c</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>0.15±0.11d</td>
<td>1.84±0.01c</td>
<td>3.00±0.01b</td>
<td>3.43±0.03a</td>
</tr>
<tr>
<td>Ca (mg*g(^{-1}))</td>
<td>1.22±0.02c</td>
<td>1.6±0.06b</td>
<td>1.71±0.12b</td>
<td>1.87±0.14a</td>
</tr>
<tr>
<td>Zn (mg*g(^{-1}))</td>
<td>0.06±0.09d</td>
<td>0.07±0.11c</td>
<td>0.08±0.03b</td>
<td>0.09±0.03a</td>
</tr>
</tbody>
</table>

Mean ± standard deviation; Means with different superscripts within a raw differ significantly (P =.05); SM: Soy and Millet Flours; levels of inclusion (%) are indicated in parenthesis.
of food product [22]. Soy protein is commonly used in processed meat as a binder to reduce processing cost and increase yield. One of the most important attributes in sausages and other emulsified products is the ability to hold moisture and fat inside the product [2]. Cooking loss is a practical method for determining water and fat loss during cooking of sausages [11]. The formulations with corn and cassava flour produced higher cooking yields of quail meatballs probably due to their ability to retain moisture in the matrix [22].

Meat products appeared to have improved water holding capacity and emulsion stability due to the added dietary fiber flours which has therefore lead to a higher cooking yield [23]. Fiber is suitable for meat products preparation because of its water retention property, decreases cooking loss and neutral flavor [5]. The trend in weight changes showed an increase in weight due to the increasing ability of the soy flour to bind moisture. This is consistent with the findings that replacement of meat with legumes resulted in reducing drip losses of [24].

Moisture retention value represents the amount of moisture retained in the cooked product. The moisture retention capacity was enhanced by the incorporation of soy and millet flours in beef sausage formulations. The moisture retention of the beef sausage using 30% substitution level was highest (31.73%) compared with others and lowest using 0% (control) (26.60%). The value of moisture retention is increased with significant value (p=.05) due to soy and millet flour inclusions and also might be the increment of moisture, fat and protein content of the product. The maximum moisture retention of beef sausage is 21.9-24.4% [19]. Current study indicated that the moisture retention were between and above this range due to the other composition variation of the raw materials.

Fat retention value represents the amount of fat retained in the cooked sausage product. The fat retention in beef sausage 30% inclusion level was the highest (91.07%) and the lowest value 0% inclusion level (86.88%). This results shows that fat retention is increased with increasing inclusion of soy and millet flour.

Shrinkage in the weight and volume of meat because of the loss of fat and moisture is appreciable [25]. The fat retention in low-fat meatballs containing legume flours as extenders was 95.5% (lentil flour), 95.0% (black eye bean flour), 92.8% (chickpea flour) and 82.8% (rusk) [18]. Potato and cassava flour formulations produced higher cooking yields 97.99% and 98.97% and higher fat retentions (85.22 and 85.91%) respectively than the other treatments. The fat retention of beef sausage using soy and millet flours is slightly low than the indicated results it might be the inclusion level and chemical composition of the raw materials [19]. The product formulation and processing methodology are key determinants of fat loss and weight loss during the cooking of products such as sausages [25].

The juiciness in beef sausage 30% inclusion level was the highest (16.99%) and the lowest value 0% inclusion level (15.01%). This result showed that juiciness is increased with increasing inclusion of soy and finger millet flour with a significant different (P=.05) in treatments. The loss of moisture and fat also affects the moisture retention, fat retention and juiciness of samples. The juiciness in meatballs ranged from 14.40-15.74% using different flour formulation [19] and the juiciness of cooked patties was 12.87% with the addition of 20% textured soy and also found that juiciness decreased with decreasing fat levels in baked patties from goat meat [15]. The variation of juiciness in the sausage is depending on the inclusion levels and type of raw materials and the fat and moisture.

### Table 3. Physical properties of sausage product

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mr</th>
<th>Fr</th>
<th>Juiciness</th>
<th>Weight loss</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM (0%)</td>
<td>26.60±0.51&lt;sup&gt;a&lt;/sup&gt;</td>
<td>86.88±0.58&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15.01±0.81&lt;sup&gt;b&lt;/sup&gt;</td>
<td>43.09±0.61&lt;sup&gt;a&lt;/sup&gt;</td>
<td>56.91±0.24&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>SM (10%)</td>
<td>28.31±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>86.82±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>15.22±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39.21±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>60.79±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>SM (20%)</td>
<td>30.93±0.07&lt;sup&gt;b&lt;/sup&gt;</td>
<td>87.89±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16.46±0.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.18±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>67.82±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>SM (30%)</td>
<td>31.73±0.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>91.07±0.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.99±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.75±0.04&lt;sup&gt;d&lt;/sup&gt;</td>
<td>77.24±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Mean ± standard deviation;<br>
Means with Different superscripts within a column differ significantly (P=.05);<br>SM: Soy and Millet Flours; levels of inclusion (%) are indicated in parenthesis.
levels of the product. The incorporation of soy protein isolate slightly improved texture, juiciness and color of emulsion sausage [3]. Soy proteins one of non-meat proteins are widely used as meat binders because of their several functionalities such as water holding, binding and emulsifying properties. They have been incorporated into comminuted meat to improve physical and chemical properties of processed meat products. Soy protein addition into sausage results in better binding and texture of sausage.

3.3 Sensory Quality of Sausage

The sensory evaluations of beef sausage are shown in Table 4. The sensory evaluation of beef meat formulated from soy and millet flours with different proportion gave scores denoting neither like nor dislike 5%, moderate likeability is 75%, and like very much 20% based on a 7-point hedonic scale.

Taste is the main criterion that makes the product to be liked or disliked. The results show that the higher score of taste at 20% inclusion level (5.98) and the lowest score were recorded at 30% inclusion level (4.12). These scores denote moderate acceptability on a 7-point hedonic scale. With respect to flavor, beef sausage generally produced a score denoting moderate acceptability, with the high score of 20% inclusion level (6.11) and lower value of at 30% inclusion level (5.21). Color is very important parameter in judging the properly of sausage products because it does not only reflect the suitable raw material used for the preparation but also levels of inclusion (%) are indicated in parenthesis. From the result the high score was recorded on 20% inclusion level (6.99).

Appearance is the other important quality parameter in sausage products. The appearance score for the beef sausage were scored above 5 in 7-hedonic scale. The results show that the higher score of appearance at 20 and 30% inclusion level had 6.04 and the lowest score was recorded at 10% soy inclusion (5.13). The appearance of beef sausage was affected by the substitute of soy and finger millet flours and the cooking temperature.

The overall acceptability values for the beef meat formulated from soy and finger millet flours were examined in the above Table 4. The products were scored above 5 in 7-hedonic scale which indicated that the overall acceptability was acceptable by panelists with the value of “like moderately” and “like very much”. The highest overall acceptability score were recorded on 20% inclusion level had the value of 6.46 and lowest value was recorded in 10% inclusion level had the value of 5.38.

Soy protein contributes to the nutritional and general overall eating quality of meat products [7]. It has also been reported that preference of acceptance testing is often used to evaluate products reformed with soy ingredients and it is not common to find reports of reformulated products that are significantly preferred over the all meat control. The products were generally accepted. But in this study particularly indicated that inclusion level up to 20% is acceptable (“like very much”).

3.4 Cost Analysis of Sausage

Cost analysis is the critical point for the formulation of various ingredients to produces meat products. Soy proteins are commonly used in processed meat products for their functional properties and low cost compared to beef meat products [26]. Cost analysis of the soy and millet sausage produced in this study showed that as soy and finger millet flour inclusion increased the cost of production decreased Table 5. The beef sausage was formulated in different flours and spices in a total of 1150 g per mix in each treatment. At 0%, 10%, 20% and 30% soy-millet flour inclusion, there was a cost reduction of 177, 162, 152, and 142 ETB respectively. From this to generalized that, the inclusion of 30% soy-millet flour in the formulation of beef sausage, the cost was reduced by 35 ETB per mix.

Table 4. Sensory values of meat and soy flour blend sausage product

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Taste</th>
<th>Flavour</th>
<th>Colour</th>
<th>Appearance</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM (0%)</td>
<td>5.29±0.40</td>
<td>5.65±0.05</td>
<td>5.47±0.13</td>
<td>5.29±0.01</td>
<td>5.53±0.61</td>
</tr>
<tr>
<td>SM (10%)</td>
<td>5.95±0.06</td>
<td>5.91±0.12</td>
<td>5.15±0.02</td>
<td>5.13±0.12</td>
<td>5.38±0.21</td>
</tr>
<tr>
<td>SM (20%)</td>
<td>5.98±0.31</td>
<td>6.11±0.12</td>
<td>6.99±0.31</td>
<td>6.04±0.31</td>
<td>6.46±0.81</td>
</tr>
<tr>
<td>SM (30%)</td>
<td>4.12±0.03</td>
<td>5.21±0.32</td>
<td>6.19±0.14</td>
<td>6.04±0.45</td>
<td>5.56±0.02</td>
</tr>
</tbody>
</table>

Mean ± standard deviation,
SM: Soy and Millet Flours; levels of inclusion (%) are indicated in parenthesis
Table 5. Cost analysis (birr) of sausage

<table>
<thead>
<tr>
<th>Ingredients (ETB)</th>
<th>SM (0%)</th>
<th>SM (10%)</th>
<th>SM (20%)</th>
<th>SM (30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef meat</td>
<td>156</td>
<td>135</td>
<td>120</td>
<td>105</td>
</tr>
<tr>
<td>Soy bean</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Millet</td>
<td>0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Water</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>pepper</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Salt</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Garlic</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Onion</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ginger</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Total amount per mix (birr)</td>
<td>177.00</td>
<td>162.00</td>
<td>152.00</td>
<td>142.00</td>
</tr>
</tbody>
</table>

4. CONCLUSION

Soybean and finger millet flour, which is one of the ingredient in sausage production. The beef sausage product formulated from soybean and finger millet flours were enhancing the physicochemical and sensory qualities of sausage. Soy-millet flour inclusion up to 20% is acceptable (“like very much”) at better product. The addition of soy and finger millet flours are commonly used in processed meat as a binder to reduce processing cost and increase yield. Generally concluded that, soy and finger millet flour ingredients reduced the cost, improved the quality attributes and consumer acceptability of meat products. Beef meat can be used successfully for the production of beef meat sausage as an alternative uses of different flours. Soy and millet formulated beef sausages can therefore be recommended for inclusion into the diets of different categories of individuals based on health needs and non-meat alternative ingredients which is relatively cheap in economic production of these nutritious sausages products.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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