



Sensory impacts of fresh oyster mushroom (*Pleurotus ostreatus*) addition in beef sausage

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Abstract

The nutritional and functional value of oyster mushroom (*Pleurotus ostreatus*) has gained global recognition due to its desirable taste, flavour, high nutrient content, and medicinal properties. Conventional beef sausages, while popular, are often criticized for their high fat, cholesterol, and salt content, which contribute to diet-related non-communicable diseases. Reformulating sausages with healthier ingredients offers a potential solution to this public health concern. This study therefore aimed to determine the impact of fresh oyster mushroom addition on the sensory properties of beef sausage. Four sausage formulations were prepared at varying addition levels of fresh oyster mushroom, and these were: 0%, 25%, 50% and 75%. Sensory evaluation was conducted by 150 participants using a 5-point hedonic scale to assess colour/appearance, aroma/odour, texture/mouthfeel, taste, and overall acceptability of the different sausage formulations. The results revealed significant differences across treatments, with sensory scores declining as fresh oyster mushroom concentration increased. Sausage formulation B (25% fresh oyster mushroom addition) was generally more acceptable compared to other mushroom-containing formulations, balancing improved nutritional value with consumer preference. The findings suggest that incorporating fresh oyster mushroom at a 25% addition level optimizes sensory acceptability, providing a viable strategy for developing healthier beef sausages without compromising consumer satisfaction.

Keywords: Addition, Beef sausage, Oyster mushroom, Sensory evaluation

Introduction

Sausages are foods made from grounded or minced meats. They are among the oldest processed foods, different formulations across the world, reflecting cultural, economic, and social significance (Carballo, 2021) ^[41]. They are produced from diverse animal meats such as pork, beef, chicken among others. In addition, they can be processed in forms including raw, cooked, scalded, and fermented, each imparting distinct physico-chemical and microbiological characteristics (Wu *et al.*, 2022) ^[38]. Fermented sausages for instance, benefit from controlled microbial activity that enhances flavour and shelf stability, while cooked sausages undergo thermal treatment to ensure safety and immediate edibility. Such processing variations influence nutritional quality, safety, and consumer preferences (Gorlov *et al.*, 2020) ^[40].

The popularity of sausages is attributed to their nutritional value, convenience, and sensory appeal (Wu *et al.*, 2022) ^[38]. However, conventional formulations are often high in fat, cholesterol, and added salts, while lacking dietary fiber and antioxidants (El-Ramady *et al.*, 2022) ^[17]. Excessive consumption of these products has been linked to obesity, cardiovascular diseases, hypertension, and certain cancers

(Yahya & Ting, 2020) ^[39]. With growing awareness of diet-related non-communicable diseases, consumers are increasingly demanding healthier and more sustainable meat products (Das *et al.*, 2021; Liu *et al.*, 2022) ^[14, 25]. This prompted innovation in reformulating sausages by adding mushroom as an ingredient in the beef sausage making process. (Das *et al.*, 2020) ^[12].

Oyster mushroom can act as a healthy addition due to its high-quality protein, fiber, vitamins, minerals, and bioactive compounds with antioxidant, antimicrobial, and cholesterol-lowering properties (Banerjee *et al.*, 2020; Mattila *et al.*, 2019) ^[10, 27]. Its low fat and calorie content make it particularly suitable for health-conscious and flexitarian consumers. Previous studies show that mushroom incorporation can enhance nutritional quality and reduce fat in meat products (Wong *et al.*, 2019; Das *et al.*, 2020) ^[13]. Yet, limited research has examined how fresh oyster mushroom addition specifically affects the sensory properties of beef sausages. Since consumer acceptance is the ultimate determinant of commercial viability, understanding sensory impacts is critical.

Therefore, this study investigated the impacts of adding fresh oyster mushroom proportions on the sensory characteristics of beef sausage.

Methodology

The study was conducted in Gulu City, Northern Uganda, and employed a mixed methods design combining quantitative sensory scores with qualitative consumer feedback. Four

treatments representing different sausage formulations as shown in table 1 were formulated by varying the proportions of fresh oyster mushroom (*Pleurotus ostreatus*) incorporated into beef sausages.

Table 1: Formulation of sausages with different addition levels of fresh *P. ostreatus*.

Formulation	A	B	C	D
Addition level of fresh <i>P. ostreatus</i>	0%	25%	50%	75%
Ingredients (g)				
Minced beef	5,000	3,750	2,500	1,250
Minced fresh oyster mushroom	0	1,250	2,500	3,750
Sodium Metabisulphite	5	5	5	5
Monosodium Glutamate	50	50	50	50
Ginger spice	25	25	25	25
Nutmeg spice	25	25	25	25
Coriander	25	25	25	25
Garlic powder	50	50	50	50
White pepper	25	25	25	25
Salt	160	160	160	160
Animal fat	5,000	5,000	5,000	5,000
Baking powder	200	200	200	200
Wheat flour	5,000	5,000	5,000	5,000
Ice	5,000	5,000	5,000	5,000

A=All-beef control

Fresh lean beef was procured from a certified butcher, while oyster mushroom was harvested locally, cleaned with clean running water, and cut into small pieces. Standard sausage formulation ingredients such as salt, spices, and binders were

kept constant across all treatments, and sausages were prepared using conventional methods of mincing, mixing with mushroom at specified levels, stuffing into casings, and cooking under controlled conditions as shown in figure 1.

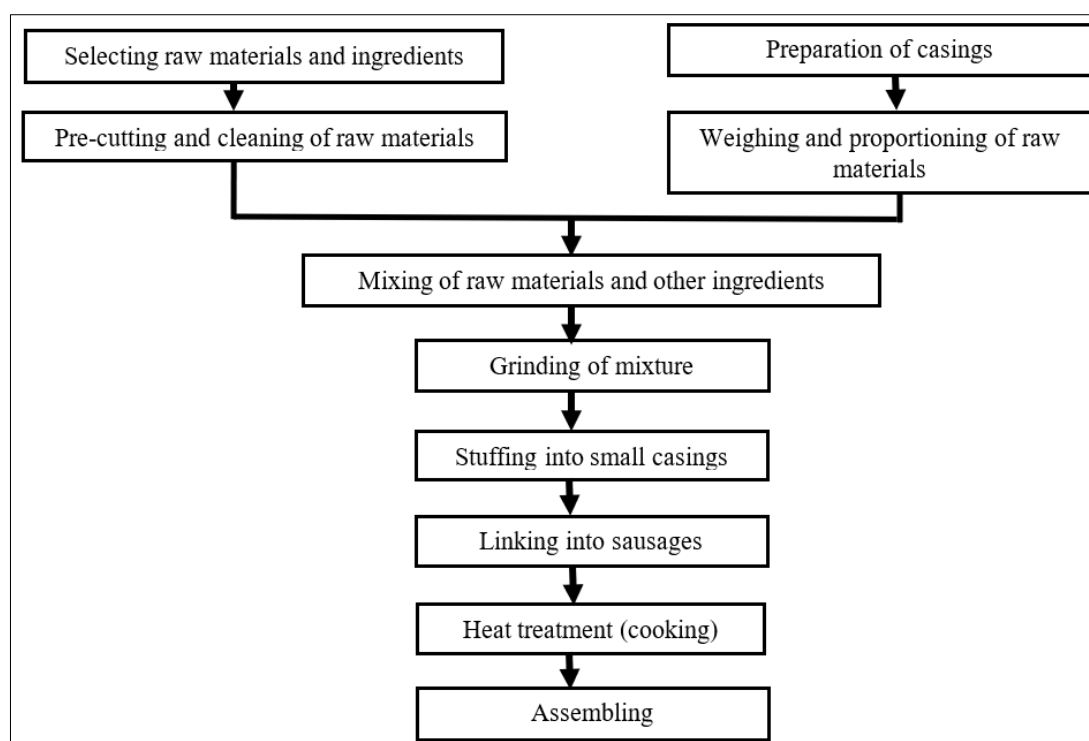


Fig 1: A summary of the sausage preparation stages (Heinz and Hautzinger, 2007)

A total of 150 participants evaluated the sensory properties of the sausages, focusing on appearance, aroma, texture, taste and overall acceptability. A five-point hedonic scale (1=Dislike

Extremely, 5=Like Extremely) was used, with samples coded and presented randomly to participants to minimize bias. Quantitative data was collected from the sensory scores and

analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. One-way ANOVA was performed to determine significant differences among treatments at 5% level of significance, while qualitative feedback from participants was documented to provide descriptive insights into consumer perceptions. Ethical approval was obtained, informed consent was secured from all participants, and strict hygiene and food safety protocols were observed throughout the study.

Table 1: Mean scores of sensory characteristics of beef sausage segregated by sausage formulation

Sensory characteristics	Formulation				p-value
	A	B	C	D	
	Mean Score	Mean Score	Mean Score	Mean Score	
Appearance	4.33±0.94 ^a	4.12±0.89 ^{ab}	3.91±1.04 ^{bc}	3.70±1.14 ^c	0.00
Aroma	4.47±0.74 ^a	4.07±0.91 ^b	3.69±0.99 ^c	3.49±1.14 ^c	0.00
Texture	4.70±4.38 ^a	3.84±1.00 ^b	3.53±1.09 ^b	3.32±1.19 ^b	0.00
Taste	4.51±0.81 ^a	3.93±0.98 ^b	3.47±1.07 ^c	3.34±1.19 ^d	0.00
Overall acceptability	4.43±0.79 ^a	3.94±0.88 ^b	3.51±1.12 ^c	3.25±1.18 ^c	0.00

Values are presented as Mean±SD and mean scores with different superscripts in the same row are significantly different ($p<0.05$).

Score 5-Like extremely, score 4-Like slightly, score 3-Neither like nor dislike, score 2-Dislike slightly and score 1-Dislike extremely.

A=All-beef control (100% beef and 0% fresh oyster mushroom); B=Most acceptable formula (75% beef and 25% fresh oyster mushroom); C=Beef sausage with 50% beef and 50% fresh oyster mushroom; D=Beef sausage with 25% beef and 75% fresh oyster mushroom.

Appearance

Sausage samples without fresh oyster mushroom (Formulation A) received the highest score for appearance (4.33±0.94), compared to formulations B (4.12±0.89), C (3.91±1.04) and D (3.70±1.14). A progressive reduction in the scores for appearance was observed with increasing content of fresh oyster mushroom. Among the sausage formulations containing fresh oyster mushroom, sample B (25% fresh oyster mushroom) was rated highest (4.12±0.89).

Although appearance scores decreased progressively with increasing fresh oyster mushroom content, a significant difference ($p<0.05$) was observed among the sausage formulations. This suggests that moderate incorporation of fresh oyster mushroom in beef sausage may be visually acceptable. The decline in the scores for appearance in formulations C and D may be attributed to the high moisture content of fresh oyster mushroom which is up to 91.66% (El-Refai *et al.*, 2020) [18]. This might have contributed to the soggy appearance of the beef sausages, hence reduced scores. These findings are consistent with previous studies by Al-Dalain (2018) [7]; Banerjee *et al.* (2020) [10]; Wang *et al.* (2019) [37] and Park *et al.* (2023) [32] who reported similar declines in visual appearance of similar meat products with mushroom addition.

Texture

The scores for texture of sausages followed a similar trend, with formulation A scoring highest (4.70±4.38) among all formulations. Sausage formulations B, C and D were scored for texture at 3.84±1.00, 3.53±1.09 and 3.32±1.19 respectively,

Results and Discussion

The sensory evaluation results are shown in Table 2. Overall, the sensory evaluation of both control and fresh oyster mushroom addition groups revealed statistically significant differences ($p<0.05$) across all the sensory characteristics that were assessed: appearance, aroma, texture, taste, and overall acceptability.

indicating a decline in texture rating with increasing rates of fresh oyster mushroom addition. Addition of fresh oyster mushroom in sausage formulations significantly ($p<0.05$) reduced texture rating. This suggests that sausages without fresh oyster mushroom had a more desirable texture compared to fresh oyster mushroom-containing sausages. This could indicate that fresh oyster mushroom affected the texture of the sausage, potentially resulting in a different mouthfeel that was less preferred by the participants. The increase in fresh oyster mushroom content may have contributed to a softer, less desirable texture, possibly due to high moisture content. This observation aligns with findings by Mazli *et al.* (2023) [28], who reported a watery texture in meat products enriched with mushroom.

Aroma

The mean scores for aroma of sausages without fresh oyster mushroom were the highest (4.47±0.74), while formulation D had the lowest score (3.49±1.14). Among the sausage samples containing fresh oyster mushroom, formulation B scored high (4.07±0.91), compared to C and D.

There was a significant difference ($p<0.05$) in aroma scores among the sausage formulations. The scores generally decreased with increasing levels of fresh oyster mushroom inclusion, indicating that the addition of fresh oyster mushroom significantly influenced the aroma of the beef sausages. The decline in aroma acceptability of sausages may be due to the unique flavour compounds in oyster mushroom which could have altered the typical aroma profile of beef, potentially influencing overall sensory perception. This indicates that sausages without fresh oyster mushroom had a more appealing smell compared to fresh oyster mushroom-containing sausages. In contrast to the findings of this study, some studies (Mazli *et al.* (2023) [28] and Fu *et al.* (2023) [20] reported enhanced aroma with mushroom incorporation in similar meat products, while others (Novakovic *et al.* (2020) [30] and Patinho *et al.* (2019) [33] found no significant differences.

Taste

Across formulations, the scores for taste were low and varied from each other. Taste scores were highest (4.51 ± 0.81) for formulation A (without fresh oyster mushroom) and lowest (3.34 ± 1.19) for formulation D (with 75% fresh oyster mushroom).

The taste rating for sausages significantly ($p < 0.05$) declined with an increase in the content of fresh oyster mushroom, suggesting that the flavour profile of oyster mushroom may not be well integrated into beef sausages at higher addition levels. The reduction in taste perception with increased fresh oyster mushroom content could be attributed to changes in fat content and the distinct flavour profile of fresh oyster mushroom, as noted in studies by Mazli *et al.* (2023) [28].

Overall acceptability

The overall acceptability of the sausages reflected the trends observed in individual sensory attributes. Formulation A (without oyster mushroom) received the highest score (4.43 ± 0.79), while formulation D (75% fresh oyster mushroom) was least acceptable (3.25 ± 1.18). As the proportion of fresh oyster mushroom increased, overall acceptability declined significantly ($p < 0.05$), with formulations B, C and D showing progressively lower scores. Among the mushroom-containing samples, formulation B (25% substitution) was the most acceptable, suggesting a potential threshold for consumer preference.

The decline in sensory scores with higher fresh oyster mushroom inclusion may be attributed to changes in texture, aroma, and taste, influenced by the physico-chemical and rheological properties of the product. Mushrooms contribute a firm and fibrous texture that when combined with beef can enhance mouthfeel up to a certain level of incorporation. Beyond this threshold, however, the dense structure and altered flavour profile may negatively affect consumer perception. These findings highlight the importance of balancing nutritional innovation with sensory quality to ensure consumer satisfaction.

The results are consistent with Park *et al.* (2023) [32], who reported similar declines in sensory acceptability with increased mushroom content in meat products. However, contrasting findings have been noted by Novakovic *et al.* (2020) [30] and Mazli *et al.* (2023) [28], who observed improved sensory attributes in certain mushroom-enriched formulations. This suggests that optimization of processing methods, ingredient ratios, or mushroom preparation techniques may mitigate sensory challenges and enhance the acceptability of mushroom-based meat products.

Conclusion

The addition of fresh oyster mushroom to beef sausage formulations was not universally accepted, with consumer preference strongly dependent on the level of addition. Sensory evaluation demonstrated that higher fresh oyster mushroom inclusion led to significant declines in overall acceptability, largely due to changes in texture, aroma, and taste. However, incorporation at the 25% level provided a balance between

nutritional improvement and consumer satisfaction, identifying a potential threshold for partial addition. In light of the health concerns associated with red meat consumption and the recognized nutritional and functional benefits of oyster mushrooms, this study highlighted the value of oyster mushroom as a functional ingredient for developing nutritionally superior and next-generation healthier meat products. Partial replacement of beef with fresh oyster mushroom at 25% level is therefore recommended as a viable strategy to enhance the nutritional profile of sausages without compromising sensory quality.

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