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1. Meat Science Laboratory, Department of Animal Production, Olabisi Onabanjo University, Ayetoro Campus, P.M.B 0012 Ayetoro, Ogun state, Nigeria
2. Department of Wildlife and Ecotourism Management, University of Ibadan, Ibadan Oyo state, Nigeria

***Corresponding author:**

OC Apata
E- mail: ebunoluapata2008@yahoo.com

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Research Article

Quality and acceptability evaluation of soy-cheese (Tofu) enhanced with meat

ES Apata[1], RA Sunmola[1], OO Olaleye[1] and OC Apata[2*]

Abstract

The study was carried out to determine the quality and acceptability of soy-cheese (Tofu) enhanced with different meat types. 40g of raw soybeans, 40g of each meat type-beef, mutton, chevon, chicken and 5g of industrial grade calcium sulphate ($CaSo_4$) were used for this study. The meat types + Tofu constituted the treatments, thus: T_0 = Tofu only (control), T_1 = Tofu + beef, T_2 = Tofu + mutton, T_3 = Tofu + chevon, T_4 = Tofu + chicken meat. Data were collected and analysed using analysis of variance (ANOVA) at $p<0.05$. The meat Tofu products samples showed significant differences ($p<0.05$) in physical, chemical and the sensorial variables tested with chicken meat Tofu (T_4) having highest ($p<0.05$) yield, water holding capacity, protein, fat, ash, all the organoleptic and overall acceptability values. This study supplied first hand information on the effect of meat inclusion in Tofu, therefore, chicken meat could be included in Tofu at ratio of 1:1 for quality and acceptability enhancement.

Introduction

Tofu, which is also known as soy-cheese or bean curd has its origin from China and became popular during the Sun dynasty (Buell, 2018). It was common among civilian in Japan, then to the nest of Southeast Asia and later spread over the world with the advance of its science and technical development (Shurtleff and Aoyagi, 2013; Dey *et al.*, 2017). It is highly nutritious gel-like food product, that is manufactured from soybean and is low in calorie and saturated fat, rich in essential amino acids, contains iron, high in vitamins and contains antioxidant with better digestibility (Yakubu and Amuzat, 2012; Ndite *et al.,* 2018). Tofu can be classified into firm/soft, packed/pressed and fermented types based on product characteristics and the different coagulants used in the preparation (Zhang *et al*., 2018), the hardness and water contents to meet the different needs and expectations of consumers (Rinaldoni *et al.,* 2014).

However, meat continues to play an important role in the human diet by providing good source of high quality protein, beneficial fatty acids and variety of micronutrients for optimal health (Akter et al., 2009; Ali et al., 2022; Bithi et al., 2020; Boby et al., 2021; Milton, 2003; Sarker et al., 2021). It has been reported that without inclusion of animal source foods in diets, it is unlikely that man could not have achieved their unusual large and complex brain while simultaneously continue with their evolutionary trajectory as large, active and highly social primates (Pobnier, 2013). Meat consumption trends vary greatly around the world in the forms of roast, ribs or steaks, ground or minced like patties or hamburgers, while processed meats include canned meat, jerky and sausages (Pobiner, 2016). In as much as Tofu is regarded as a rich food from vegetable it had been reported that it lacks vitamin K which is responsible for blood clotting and vitamin D that is an important element in the absorption and retenance of calcium and phosphorus which are critical to building of bones (Carter, 2018; Royal osteoporosis society (ROS), 2022).

It was also reported that Tofu has low fat which is responsible for cohesive and juicy bite in food and contains phytates which can reduce the absorption of minerals such as calcium, iron and zinc in the body as well as has isoflavone a type of plant estrogen which is capable of disrupting hormonal function in the body (Nanvri *et al.,* 2010). In another hand, meat lacks vitamin C which is a powerful antioxidant very important for maintenance of connective tissues as well as functions as a co-factor for many enzymes in the body (Anitra and Jens, 2017). But it has vitamin B12 in abundance, calcium, zinc and heme iron which is much better absorbed in the body than non-heme iron in plant foods (Larsson and Orsin 2014; Joshi and Kumar, 2015). Many consumers are demanding for healthy food due to health concern and for healthy and balanced diets. There is the need to incorporate beneficial plants nutrients into meat products for synergy in human body. This study was carried out therefore to investigate the effect of incorporating meat on the quality and acceptability of Tofu.

Materials and Methods

Procurement of raw materials

2kg soybeans (Glycine max) 1kg of each meat type-beef, chevon, mutton and chicken and 50g of calcium sulphate ($CaSO_4$) industrial grade were purchased at Lafenwa market in Abeokuta and were conveyed to the meat Science Laboratory in the department of Animal Production, Olabisi Onabanjo University, Ayetoro campus, Ogun state.

Preparation of Soycheese plus meat samples

Soycheese samples were prepared following the procedures described by Yakubu and Amzat, 2012, Ndife *et al.*, 2018. The soybeans were sorted to remove extraneous materials, washed to remove dirts and soaked in 6 litres of clean water at 40^0c for 9hours. The soaked beans were drained, dehulled, weighed and ground with a laboratory grinder (Kenwood 358 Chef UK) into paste and tap water was added at a ratio of 6:1 and then filtered to separate soycake from soymilk with muslin cloth by squeezing out as much filtrate as possible. The soymilk was divided into four portions of 40g w/w. 5 percent of $CaSO_4$ was prepared by dissolving 50g $CaSO_4$ in 1000ml of distilled water and added to the separate soybean milk portions. 1kg of each meat type was minced with a laboratory meat mincer (Kenwood KW71536, UK) with 10mm blade after chilling at 4°C for 24 hours at 420 rpm for 10 seconds according to Yakubu and Amuzat, 2012.

Mixing of soybean and minced meats

The soybean milk and $CaSO_4$ were mixed with minced meat samples of beef, mutton, chevon and chicken using the same mincer at the same speed for 20 seconds. Each of the soybean milk and meat sample constituted a treatment as shown in Table 1.

Table 1. Percentage composition of ingredients for Tofu enhanced with different meats

Ingredients (g)	**Treatments**				
	T_0 (SB)	**T_1 (BF)**	**T_2 (MT)**	**T_3 (CV)**	**T_4 (CK)**
Soybean milk	80.00	40.00	40.00	40.00	40.00
Beef	-	40.00	-	-	-
Mutton	-	-	40.00	-	-
Chevon	-	-	-	40.00	-
Chicken	-	-	-	-	40.00
Calcium sulphate	5.00	5.00	5.00	5.00	5.00
Red pepper	3.00	3.00	3.00	3.00	3.00
Vegetable oil	5.00	5.00	5.00	5.00	5.00
Seasoning	2.00	2.00	2.00	2.00	2.00
Salt	5.00	5.00	5.00	5.00	5.00
Total	100.0	100.00	100.0	100.00	100.00

SB =Soybeans, BF = Beef, MT= Mutton, CV = Chevon, CK = Chicken, T_0 = Tofu only, T_1 = Tofu + beef, T_2 = Tofu + mutton, T_3 = Tofu + chevon, T_4 = Tofu + chicken.

Boiling of soybean milk + meat samples

The mixture of soybean milk and each meat sample were heated to boil at 98°C for 30mins until the curd formation and were allowed to cool to room temperature (27°C), weighed and preserved at 4°C overnight in the refrigerator prior to analysis (Yakubu and Amuzat, 2012; Rajin *et al.*, 2018; Ndife *et al*., 2018)

Analysis of parameters

Physical characteristics of meat Tofu

The physical properties of meat Tofu (cooking loss yield, thermal shortening and WHC) were determined following the procedures described by Apata *et al* (2018).

Chemical properties of meat Tofu samples

The determination of the chemical composition of the meat Tofu samples for moisture, crude protein, either extract (fat), ash, and carbohydrate was carried out by the methods described by AOAC (2005) while pH was determined according to Marduori and deFelicio (2003).

Sensorial characteristics of meat Tofu samples

The sensory evaluation of the meat Tofu samples was conducted following the methods described by Iwe (2010) and AMSA (2015). 10-member semi-trained panelists were randomly selected from the staff and students of the Department. Sensory quality attributes such as flavour, taste, texture, juiciness and overall acceptability of the products were scored on a 9-point hedonic scale on which 1= dislike extremely, 5 = neither like nor dislike and 9=like extremely, while the colour of the products was evaluated using (AMSA, 2012) visual colour chat on which 1 = very low intensity and 8 = very high intensity.

Experimental design and statistical analysis

The experimental set-up was based on completely randomized design. All data collected were subjected to analysis of variance (ANOVA) using (SAS, 2002). Significant differences between means were separated with Duncan multiple range test of the same statistical analysis software at $p<0.05$.

Results and Discussion

The results of physical characteristics of Tofu enhanced with different meat types are presented in Table 2. There were significant differences ($p<0.05$) in the cooking loss, yield, thermal shortening and water holding capacity of the products. Cooking loss (10.17) and thermal shortening (10.10) (T_4) were lower ($p<0.05$) in Tofu with chicken meat, while Tofu only T_0 had highest cooking loss (16.00) and thermal shortening (13.12). Cooking yield (89.83) and water holding capacity (67.88) were higher in Tofu with chicken (T_4) than in other treatments. The significant differences observed in the physical properties Tofu enhanced with different meat types could be attributed to the chemical components of the meat types. Tofu with chicken meat (T_4) was observed to be able to retain most of the inherent internal moisture in terms of water holding capacity (67.88) and lost an insignificant juice during processing to maintain a significant value for cooking yield of 89.83% followed by Tofu with mutton (T_3) and least (56.25) ($p<0.05$) in Tofu without meat inclusion (T_0). These results were in agreement with the finding of Rinaldoni *et al* (2014) who reported that there was an improvement in a soft cheeselike product that was enriched with soy protein concentrate indicating that Tofu quality factors could be improved by addition of protenious materials especially from animal source. It was obvious from the data on Table 2 that Tofu that had meats added to it got improved in physical factors when compared with Tofu alone without meat inclusion.

Table 2. Physical characteristics of Tofu enhanced with different meats

Variable (%)	**Treatments**					
	T_0 (SB)	**T_1 (BF)**	**T_2 (MT)**	**T_3 (CV)**	**T_4 (CK)**	**SEM**
Cooking loss	16.00^a	14.39^b	13.27^c	14.61^b	10.17^d	1.76
Cooking yield	84.00^d	85.61^c	86.73^b	85.39^c	89.83^a	2.08
Thermal shortening	13.12^a	12.23^b	11.21^c	12.32^b	10.10^d	0.47
WHC	56.25^e	62.63^c	64.65^b	60.35^d	67.88^a	1.53

SB =Soybeans, BF = Beef, MT= Mutton, CV = Chevon, CK = Chicken, WHC = Waterholding capacity, SEM = Standard error of means.

Table 3 shows the results of proximate composition and pH of Tofu enhanced with different meats. The moisture content was lowest (50.70) $p<0.05$ in Tofu enhanced with chicken meat (T_4) and similar to that which was enhanced with chevon (T_3) with (50.60%) moisture compared with other treatments. However, the protein (24.64) and ash (9.30) contents of chicken Tofu (T4) were higher than Tofu with both beef and chevon but similar to those of mutton (T2) and Tofu alone (T0).

It was reported by Apata (2011) that moisture and protein must be inversely related in any meat or meat products for the quality stability of the meat or meat product. Moisture creates an avenue for microbial proliferation in any meat or meat product and accelerates the spoilage of the meat or meat product and should not be too high. When protein and fat are reasonably high in meat or meat product their acceptability is also high because of enhanced juiciness. The ash (9.30) content of Tofu with chicken was comparable and statistically similar with those in T_0 and T_2 indicating that during processing most of the mineral contents in the meat samples-mutton and chicken meat were retained in the Tofu in which they were added, whereas there could be much of minerals loss from Tofu in T_1 and T_3 probably due to the effect of cooking resulting in loss of the minerals in the juices and lower yield according to Omojola (2008). The pH was lower (5.20) $p<0.05$ in chicken Tofu (T_4) and similar to those with beef (5.44) T_1, mutton (5.48) T_2, and chevon (5.44) T_3 than Tofu without meat sample T_0 with 6.50 value of pH. The spoilage of Tofu with meat samples would not be much as that of Tofu without meat sample due to the fact that the pH was high in consonance with high moisture content which could attract contamination and spoilage by microorganisms as reported by Apata *et al* (2018).

Table 3. Chemical composition and pH of Tofu enhance with different meats

Variable (%)	Treatments					
	T_0 (SB)	T_1 (BF)	T_2 (MT)	T_3 (CV)	T_4 (CK)	SEM
Moisture	54.45^a	52.67^b	51.63^c	50.60^d	50.70^d	0.58
Crude protein	21.23^d	23.42^b	23.68^b	22.62^c	24.64^a	0.57
Ether extract (fat)	10.15^e	13.27^c	16.00^a	12.20^d	15.00^b	0.42
Ash	9.50^a	7.56^b	9.50^a	8.30^a	9.30^a	0.54
NFE	6.33^a	3.08^b	0.69^c	6.28^a	0.36^c	0.44
pH	6.50^a	5.44^b	5.48^b	5.44^b	5.20^b	0.52

Means of the same row the different superscripts are statistically significant ($p<0.05$), SB =Soybeans, BF = Beef, MT= Mutton, CV = Chevon, CK = Chicken, WHC = Waterholding capacity, SEM = Standard error of means.

There were significant differences ($p <0.05$) in the sensorial properties of Tofu enhanced with different types of meat as shown on Table 4. All the organoleptic factors tested on enhanced Tofu were highest ($p<0.05$) in chicken Tofu (T_4) followed by beef Tofu (T_1), mutton Tofu (T_2), chevon Tofu (T_3) and least ($p<0.05$) in Tofu without meat (T_0) control. The highest sensorial scores obtained on chicken-Tofu could be due to the overall effects of better physical and chemical factors which have culminated in what was obtained as the sensorial properties of enhanced Tofu especially colour, taste, flavour and juiciness which are major eating quality factors that attract consumers to a particular meat type or meat product and induced their acceptability. The addition of different meats to Tofu was observed to have improved its quality factors and acceptability as reported by Jayasena et al (2010).

Table 4: Sensorial properties of Tofu enhanced with different meats

Variable (%)	Treatments					
	T0 (SB)	T1 (BF)	T2 (MT)	T3 (CV)	T4 (CK)	SEM
Colour	4.00[c]	5.00[b]	5.00[b]	5.00[b]	6.00[a]	0.21
Taste	4.10[d]	6.67[b]	5.55[c]	5.43[c]	7.85[a]	0.26
Flavour	4.50[d]	6.54[b]	6.48[b]	5.40[c]	7.93[a]	0.26
Juiciness	4.60[c]	5.65[b]	5.83[b]	4.63[c]	6.97[a]	0.15
Texture	5.00[b]	5.40[b]	5.31[b]	5.35[b]	6.45[a]	0.19
O.A	4.87[d]	6.67[b]	5.92[c]	5.89[c]	7.98[a]	0.22

Means of the same row the different superscripts are statistically significant ($p<0.05$), SB =Soybeans, BF = Beef, MT= Mutton, CV = Chevon, CK = Chicken, WHC = Water holding capacity, SEM = Standard error of means, O.A = Overall Acceptability.

Conclusion

The results from this study showed that chicken meat was the best when compared with other meat types used in the enhancement of Tofu. Chicken Tofu had superior physical, chemical and sensorial quality and acceptability than other meats included in Tofu and therefore, recommended. However, further study should be undertaken to investigate the contribution of each meat type to the nutritional quality of Tofu and cost implication for including each of the meat type in Tofu.

Conflicts of interest

The authors declared that there are no conflicts of interest

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