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Quality Attributes of Chevon Chunks Prepared with Varying Level of Soy, Oat and Chickpea Flour

Chirag Singh, V.P. Singh, Pramila Umaraw, Akhilesh K. Verma* and Varsha Vihan

Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, INDIA

**Corresponding author: AK Verma; E-mail: vetakhilesh@gmail.com*

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ABSTRACT

Present study was carried out to prepare ready to cook chevon chunks with goat meat for which different non-meat ingredients were added to provide chunks like characteristics and increase yield. Soy flour, oat flour and chickpea flour were added at different concentrations to the batter along with different condiments and spices in 3 treatment groups. Analysis of cooking yield and emulsion stability showed significant (P≤0.05) difference among the treatment group, T1 having soy flour, oat flour and chickpea flour at 10% level each showed highest cooking yield and emulsion stability. The proximate analysis also differed significantly (P≤0.05) with varying level of non-meat ingredients. Instrumental colour profile i.e. lightness (L^*), yellowness (b^*) and redness (a^*) values differed significantly (P≤0.05) among all treatment groups. All attributes of textural indices and sensory quality of chevon chunk varied significantly (P≤0.05) among samples. During sensory analysis all treatment groups received satisfactory scores on 9 point hedonic scale and T3 (Soy, oat and chickpea flour at level of 12.5%, 12.5% and 5% respectively) received significantly (P≤0.05) highest scores in appearance, flavour and overall acceptability. Overall T3 was considered best among all the treatment groups.

HIGHLIGHTS

- Non- meat ingredients like soy flour, oat flour and chickpea flour have potential to develop variety of shelf-stable meat products.
- Ready to cook chevon chunks can be prepared with varying level soy flour, oat flour and chickpea flour (12.5%, 12.5% and 5% respectively).

Keywords: Chevon chunks, soy flour, oat flour, chickpea flour, texture profile, colour, sensory attributes

Meat is recognised as the most wholesome foods available for human consumption. It contains necessary minerals and vitamins, good quality of protein, high energy but despite all the benefits, handling of meat is a big concern as cooking of meat is a hectic process and it gets spoiled easily at ambient temperature within few hours. In developing countries like India where resources for preservation of food products specially meat are limited, there is always a need of products which are shelf stable and be preserve for long at ambient temperature. With the changing life style, consumers' nowadays prefer food products which are easy to make and require least time to cook. Therefore, concept of ready to cook meals is emerging at a great pace. Non-meat ingredients in meat products plays a critical role in developing new and innovative products, which not only reduce the cost of production and enhance the nutritive value but also helps in innovating products which are shelf stable for longer time even at ambient temperature.

Soybean is one of the most commonly used vegetable protein sources in the meat industry due to its enticing technological properties such as emulsification characteristics, gelling capability, texture improvement,

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and water binding capacity (Asgar *et al*., 2010). Soybean also has intriguing functional and nutritional attributes due to its high-quality protein content and fairly well-balanced amino acid composition (Friedman and Brandon, 2001). The primary basic ingredients required to make plant-based meat products are soy protein flour, concentrate, and isolate. When soy protein is added to products, the products' protein content rises, improving their nutritional value and lowering the expansion and hardness (Biswas *et al*., 2011).

Despite many benefits, meat is low in complex carbohydrates such as dietary fibre (Vendrell-Pascuas *et al*., 2000; Verma *et al*., 2022). Among all sources, oat fibre provides more dietary fibres than other cereal grains and more antioxidants, which lower LDL cholesterol levels and reduce the likelihood of coronary diseases. In addition to these health advantages, dietary fibre addition enhances cooking yield, prevents cooking loss, improves water binding capabilities, and helps meat products retain flavour and make products economic for both producers as well as for consumers (Maheswara and Vani, 2017). Among pulses, chickpea flour is appreciated for its nutritious seeds, which are high in protein and carbohydrates. Chickpea seeds typically include 52–57% carbohydrates and 20–28% protein. It is widely acknowledged as an excellent nutritional source of proteins, minerals and vitamins in many parts of the world. Chickpeas do not possess any particular phytochemicals although it is considered to have one of the best nutritional content of any dry edible pulse.

Studies on such products based on chevon are limited and effect of different non-meat ingredients has not yet been explored. So, the present study was designed to formulate ready to cook chevon chunks that might be self-stable at ambient temperature with different non meat ingredients.

MATERIALS AND METHODS

Raw materials

Ingredients for the preparation of chevon chunks like soy flour, oats, chickpea flour, condiments and spices were procured from the local market of Meerut, Uttar Pradesh. Freshly slaughtered goat's meat was procured from local market and further operations on meat were carried out in the meat processing lab of Department of Livestock Products Technology, College of Veterinary and Animal Sciences (COVAS) Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut.

Preparation of chevon chunks

Freshly chevon was cleaned, deboned and minced in a meat mincer using 6 mm plates twice at the meat technology laboratory of Department of Livestock Products Technology, COVAS, Meerut. Ingredients like salt, spices, black pepper, soy flour, oat flour and chickpea flour was added in the minced meat in 3 different formulations as mentioned in Table 1. Preparation of batter for chunks was carried out using Inalsa food processor (Model: Kitchen Master 1000). Initially salt was added to extract out salt soluble proteins to enhance the binding of other ingredients with the meat. After blending for 1.5 minutes other ingredients were added one after another and further blending was done in food processor for another 2 min to achieve desire batter texture. Batter was taken out in pan and small balls shape chunks were prepared from the batter by hand. Cooking (primary cooking) of chunks was carried out in microwave oven (Voltas Beko) at high power (P 100) for 4.5 minutes. Sufficiently dry product was packed in LDPE bags and was stored at ambient temperature. Hydration was carried out before consuming the chunks in pressure cooker having water double the concentration of chunks until 4 whistle.

Table 1: Formulation of Chevon chunks prepared with different ingredients

Ingredients (%)	T1	T2	T3
Goat meat	61.5	61.5	61.5
Soy flour	10	15	12.5
Oat flour	10	7.5	12.5
Chickpea flour	10	7.5	5
Condiments	3	3	3
Spice mix	3	3	3
Table salt	1.5	1.5	1.5
Black pepper	1	1	1

T1: chevon chunks with 10% soy flour, 10% oat flour and 10% Chickpea flour; T2: chevon chunks with 15% soy flour, 7.5% oat flour and 7.5% Chickpea flour; T3: chevon chunks with 12.5% soy flour, 12.5% oat flour and 5% Chickpea flour.

Analytical Methods

Cooking determinants

The cooking yields of chevon chunks were determined by measuring the weight of the raw chevon chunks before and after initial cooking (microwave cooking) and calculated as the ratio of initial cooked weight to raw weight of chevon chunks and expressed in percentage.

$$\text{Cooking yield} = \frac{\text{weight of chevon chunks after cocking in g}}{\text{weight of chevon chunks before cocking in g}} \times 100$$

Emulsion stability of chevon chunk batter was determined by method cited by Baliga and Madaiach (1970) with little modifications. Low density polyethylene (LDPE) bags were filled with a 20 g raw meat batter prepared for chevon chunks and sealed before being placed in a controlled thermostatic water bath (Model: Boigen Scientific) set at 82 ºC for 20 minutes. After the process was completed, the LDPE bags were taken out of the water bath, the released fluid (water soluble solids, fat) was drained from the bag, and the weight of the cooked emulsion was recorded and emulsion stability was expressed in percentage.

Proximate composition

Moisture, protein, fat and ash content of cooked chevon chunks were determined according to the standard AOAC (1995) procedures. Carbohydrate content was determined by formula (carbohydrate = 100 – moisture + protein + fat + ash). Total calories were estimates on the basis of 100 g portion using Atwater values for protein (4.02 kcal/g), fat (9 kcal/g) and carbohydrate (4 kcal/g).

Instrumental Texture Profile analysis

Texture profile analysis of cooked as well as hydrated chevon chunks was estimated by the protocol determined by Bourne (1978) using TA-HD plus Texture Analyzer (Stable Micro Systems, UK), fitted with a 75 mm compression platen probe (P75). Triplicate samples of uniform size from each treatment group were kept in the middle of platform and compressed at a crosshead speed of 2 mms-^{1} using a 100 kg load cell and a two-cycle sequence with a trigger of 20 g. Calculations were made for cohesion, springiness (mm), chewiness (Nmm), and hardness (N). Cleaning of platform and probe was done after each sample analysis with a clean tissue paper.

Instrumental colour profile

Chroma metre (Konica Minolta, model CR 400, Japan) calibrated with a white plate was used to evaluate the colour of both cooked and hydrated chevon chunks. The *L*, a** and *b** colour system of the CIE were used to express colour (Robertson *et al*., 1977). For each sample, a total of 3 different spectral readings were obtained at various sites on the chunk samples. Estimates were made on the basis of values for lightness (*L**) (from dark to light), redness (*a**) (reddish to greenish) and for the yellowness (*b**) values (yellowish to bluish).

Sensory evaluation

The samples were evaluated for appearance, flavour, texture, juiciness and overall acceptability by a seven-member experienced panel of panellists comprised of teachers and postgraduate students from the College of Veterinary and Animal Sciences, SVPUAT, Meerut, India, using a 9-point hedonic scale, where 9 = extremely desirable and 1 = extremely undesirable. For each replicate, three sittings (n=21) were performed on samples after final cooking in pressure cooker. To cleanse the mouth between samples, tap water was provided.

Statistical analysis

The statistical package for social science (SPSS) version 22 was used to analyse the data. Duncan's Multiple Range Test was performed on treatment means that showed a significant difference (P≤0.05) according to the process outlined by Snedecor and Cochran (1995).

RESULTS AND DISCUSSION

Cooking determinants

A significant (P≤0.05) difference in cooking yield was observed among treatment groups, the highest cooking yield was observed in T1 and least in T3 (Table 2). The decreasing trend of cooking yield in treatment groups from

T1 to T3 might be due to decrease in level of chickpea from 10%, 7.5% to 5%. The results were in accordance with Elhassan *et al*. (2019) who observed that the cooking loss in sausage containing 30% chickpea flour were much lower as compared to the untreated samples. Similar observation was noticed by El-Bakheet (2017) who found that, cooking loss in beef patties decreased with the increase of corn germ flour.

Emulsion stability also followed the similar trend as of cooking yield as tighter the emulsion, the better it holds the water thus, higher will be the cooking yield (Table 2). T1 showed significantly (P≤0.05) highest emulsion stability and T3 least. The above result was in accordance with Hughes *et al*. (1997) who recorded increase in emulsion stability in frankfurters incorporated with oat fibre. The highest level of chickpea flour in T1 also contribute to increase in water binding and highest emulsion stability. Sanjay and Yadava (2008) observed an increase in emulsion stability and yield with substitution of meat with gram flour in quail meat rolls from 3 to 9% level. Nagamallika *et al.* (2005) also found that the emulsion stability was significantly (P≤0.05) enhanced by substituting chicken meat with pea flour at 5 and 10% levels in preparation of chicken patties.

Proximate composition

Moisture content showed significant (P≤0.05) difference among treatment groups. Significantly (P≤0.05) highest moisture content was observed in T1 and lowest in T3 (Table 2). Higher level of chickpea flour in T1 entraps more water in the product compared to T2 and T3. At higher level of incorporation chickpea flour enhance the yield as well as moisture retention in the product (Kilincceker, 2020).

Significantly (P≤0.05) highest protein was found in T3 and least in T1, T1 showed least protein content as T1 had higher concentration of chickpea flour which itself is lower in protein content compared to other non-meat ingredients added in the formulation and diluted to the protein content of product whereas high level of soy flour in T2 and T3 result in high protein content in the product. When soy protein is added to products, the product's protein content rises, improving its nutritional value and minimizing their expansion and hardness (Biswas *et al*., 2011).

Fat content of chevon chunks increased with increase in concentration of soy flour, significantly (P≤0.05) highest fat content was observed in T2 and least in T1 (Table 2). Similar results were observed by Odiase *et al*. (2013) in beef meat balls incorporated with soy flour at different level. Tendency of soy protein to bind free fat available in the product is the reason of increase in the fat in soy rich products (Wolf and Cowan, 1975; Roa *et al*., 1984). As T2 also contains least oat flour i.e. 7.5% therefore it did not diluted the protein content of the product, as reported by Kerr *et al*. (2005), they observed reduction in fat and protein content with increase in the level of oat flour in the product, which could be attributed to the higher level of carbohydrates and lower fat and protein content of oat flour which ultimately diluted the overall protein content of meat product.

Table 2: Physicochemical properties of chevon chunks incorporated with different level of soy, oat and chickpea flour

Parameters	T1	T2	T3
Cooking yield (%)	56.59±0.20^{c}	49.45±0.37^{b}	46.65±0.25^{a}
Emulsion Stability (%)	93.56±0.66^{c}	92.42±0.26^{b}	91.23±0.54^{a}
Moisture (%)	18.42±0.31^{c}	14.41±0.12^{b}	11.59±0.09^{a}
Protein (%)	44.69±0.33^{a}	56.20±0.26^{c}	53.57±0.53^{b}
Fat (%)	18.30±0.24^{a}	22.91±0.20^{c}	21.04±0.21^{b}
Ash (%)	5.84±0.14^{b}	5.87±0.05^{b}	4.87±0.07^{a}
Carbohydrates (%)	12.75±0.79^{c}	6.18±0.29^{a}	8.93±0.52^{b}
Energy (Kcal/100g)	395.36±0.93^{a}	434.54±1.49^{b}	440.42±1.29^{c}

Means values having small letters (a, b, c, d…...) treatment wise differ significantly (P ≤ 0.05) n = 6. T1: chevon chunks with 10% soy flour, 10% oat flour and 10% Chickpea flour; T2: chevon chunks with 15% soy flour, 7.5% oat flour and 7.5% Chickpea flour; T3: chevon chunks with 12.5% soy flour, 12.5% oat flour and 5% Chickpea flour.

Significant (P≤0.05) difference in ash content was observed in test groups, significantly (P≤0.05) least ash content was observed in T3 and highest in T1 and T2 with no significant (P≥0.05) difference among the two (Table 2). Significantly (P≤0.05) high ash content in T1 and T2 could be attributed due to high level of soy in the product as soy itself rich in ash content. Similar results were observed by Odiase *et al*. (2013) and Singh et al. (2021) who observed that with increase in soy flour and finger millet in meat balls and sorpotel ash content increase significantly.

Significant (P≤0.05) difference was observed in carbohydrate and energy level also, significantly (P≤0.05) highest carbohydrate content was observed in T1 and least in T2, whereas significantly (P≤0.05) higher energy was observed in T3 and least in T1 (Table 2). The highest level of chickpea flour was incorporated in T1, chickpea is rich in proteins and carbohydrates, which together constitute above 80% of total dry seeds weight. With a mean of 47.3%, the starch content (%) recorded for whole seed of various chickpea cultivars ranged from 41.0 to 50.8 (Kishor *et al*., 2017) which could be the reason of high energy vale of T1.

In cooked chevon chunks significantly (P≤0.05) highest hardness, gumminess, chewiness and resilience was observed in T2, that could be attributed due to highest level of soy flour addition in T2 which makes the chunks harder after initial cooking (Table 3). Above results were in accordance with Heywood *et al*. (2002) who also observed increase in hardness in cooked ground beef patties incorporated with texturized soy protein. Significantly (P≤0.05) low hardness, gumminess and chewiness compared to T2 was observed in T3 containing highest level of oat flour, that could be attributed due to the soft gel formation by oat flour which make product softer and less chewable. Similar results were observed by Gupta *et al*. (2018) where restructured spent hen meat slices were formulated with incorporation of barley flour and oat meal that showed significant (P≤0.05) reduction in hardness, chewiness and gumminess. Similar results were obtained by Yang *et al*. (2007) and reported reduction in hardness, gumminess and chewiness with addition of hydrated oat meal in low fat pork sausages. After final cooking in steam almost (hydrated chevon chunks), 10 folds reduction in hardness, gumminess and chewiness was observed which signifies product got good rehydration property and have a texture to be liked by the consumers.

Significant difference (P≤0.05) in L^*, a^* and b^* values was observed in the chevon chunks incorporated with different level of non-meat ingredients (Table 4). T2 showed significantly (P≤0.05) higher L^*, a^* and b^* values, that could be attributed to addition of soy flour at maximum level in T2, similar changes were observed in buffalo meat emulsion sausages incorporated with varying level of isolated soy protein where L^* and b^* values increased with increase in the level of isolated soy protein (Ahmad *et al*., 2010). Heywood *et al*. (2002) also reported that addition of textured soy protein in all beef patties produce lighter colour in turns increasing the L^* value compared to the control. Post hydration, significant (P≤0.05) difference in L^*, a^* and b^* values were noticed where lightness (L^* value) decreased (P≤0.05) in T2 and T3 but increased in

Table 3: Instrumental texture profile analysis of cooked and hydrated chevon chunks

	Cooked chevon chunks			Hydrated chevon chunks		
Groups	**T1**	**T2**	**T3**	**T1**	**T2**	**T3**
Hardness (N)	311.06±5.39 [b]	347.04±3.66 [c]	250.90±2.29 [a]	31.31±1.58 [b]	33.36±0.75 [b]	28.04±.60 [a]
Springiness (mm)	0.77±0.02 [b]	0.73±0.01 [a]	0.81±0.01 [c]	0.786±.05	0.852±.01	0.844±.008
Cohesiveness	0.39±0.01 [a]	0.48±0.004 [b]	0.49±0.01 [b]	0.515±.01	0.514±.007	0.513±.006
Gumminess (N)	120.04±0.76 [a]	166.16±2.02 [b]	122.56±2.75 [a]	15.79±.80 [a]	17.81±.49 [b]	14.28±.30 [a]
Chewiness (J)	92.87±1.61 [a]	121.71±1.78 [c]	100.18±2.30 [b]	14.27±.73 [b]	15.43±.46 [b]	12.64±.32 [a]
Resilience	0.16±0.01 [a]	0.17±0.001 [b]	0.19±0.01 [b]	0.256±.232	0.250±.238	0.26±0.001

Means values having small letters (a, b, c, d…...) treatment wise differ significantly (P ≤ 0.05) n=6. T1: chevon chunks with 10% soy flour, 10% oat flour and 10% Chickpea flour; T2: chevon chunks with 15% soy flour, 7.5% oat flour and 7.5% Chickpea flour; T3: chevon chunks with 12.5% soy flour, 12.5% oat flour and 5% Chickpea flour.

Table 4: Instrumental colour profile analysis of cooked and hydrated cooked chevon chunks

	Cooked chevon chunks			Hydrated chevon chunks		
Groups	**T1**	**T2**	**T3**	**T1**	**T2**	**T3**
Lightness (L^*)	36.72±0.29^a	39.62±0.52^b	37.57±0.42^a	41.82±0.36^c	33.87±0.35^a	38.42±.27^b
Redness (a^*)	3.78±0.05^a	4.89±0.15^b	3.68±0.13^a	3.40±0.10^a	4.10±0.08^b	3.48±0.07^a
Yellowness (b^*)	8.84±0.22^b	10.46±0.14^c	7.33±0.18^a	8.22±0.18^a	9.15±0.11^b	8.82±0.18^b

Means values having small letters (a, b, c) treatment wise differ significantly (P ≤ 0.05) n=6. T1: chevon chunks with 10% soy flour, 10% oat flour and 10% Chickpea flour; T2: chevon chunks with 15% soy flour, 7.5% oat flour and 7.5% Chickpea flour; T3: chevon chunks with 12.5% soy flour, 12.5% oat flour and 5% Chickpea flour.

T1. Overall reduction in redness (a^* value) was noticed in all treatment groups and b^* value i.e. yellowness value decreased for T1 and T2 but increased for T3. Reduction in b^* value in T1 and T2 might be due to leaching out of yellowness imparted by chickpea flour during steam cooking (hydrated chevon chunks).

Sensory Analysis of hydrated chevon chunks

Consumer sensory attributes showed significant (P≤0.05) variation in all sensory parameters. Significantly (P≤0.05) highest sensory appearance score was given to T3 and least to T1 (Table 5). The lowest appearance score in T1 could be attributed due to higher level of chickpea flour incorporation in T1, which impart yellow colour to the product which is usually disliked by the consumers. Similar results were observed in hamburgers prepared 12% level of chickpea flour incorporation (Motamedi *et al*., 2015).

Similar results as of appearance were observed in sensory flavour scores, significantly (P≤0.05) highest flavour scores were observed in T3 and lowest in T1 (Table 5) which might be attributed to the higher level of chickpea flour in T1 (Chickpea flour) which reduces the meaty flavour of the product. Above results were in accordance with Mishra *et al*. (2015) who reported that meat flavour intensity scores for products with optimum level of textured soy granule powder and barnyard millet flour incorporated in dehydrated chicken meat rings were significantly (P≤0.05) lower than control. Sanjay and Yadava (2008) also found that substituting meat with gram flour in quail meat rolls at 3% and 6% levels did not affect the sensory properties but at 9%, significant (P≤0.05) reduction in flavour and colour scores was seen. Mouth feel of beany flavour after mastication is consider to be big issue associated with non-meat ingredients added in meat products which hamper the meaty flavour.

Significantly (P≤0.05) high texture score was recorded in T2 and lowest in T1 i.e. treatment group having maximum level of chickpea flour (Table 5). T2 incorporated with maximum level of soy flour showed the highest texture score, Serdaroglu *et al*. (2005) also found that meatballs incorporated with chickpea flour showed harder texture values, and got lower scores by sensory panellists.

Juiciness score in the treatment groups showed significant (P≤0.05) variation, T2 showed significantly (P≤0.05) highest juiciness score whereas T1 and T3 were differed insignificantly (P≥0.05) (Table 5).

Table 5: Sensory evaluation values of hydrated chevon chunks incorporated with different level of soy, oat and chickpea flour

Sensory Attributes	T1	T2	T3
Appearance	6.85±0.17^a	7.14±0.23^b	7.50±0.21^c
Flavour	6.92±0.20^a	7.21±0.24^b	7.57±0.17^c
Texture	6.85±0.28^a	7.35±0.21^c	7.07±0.29^b
Juiciness	7.07±0.36^a	7.28±0.40^b	7.14±0.23^a
Overall Acceptability	6.92±0.29^a	7.35±0.34^b	7.92±0.31^c

Means values having small letters (a, b, c) treatment wise differ significantly (P ≤ 0.05) n = 21. T1: chevon chunks with 10% soy flour, 10% oat flour and 10% Chickpea flour; T2: chevon chunks with 15% soy flour, 7.5% oat flour and 7.5% Chickpea flour; T3: chevon chunks with 12.5% soy flour, 12.5% oat flour and 5% Chickpea flour.

Lower juiciness scores in T1 and T3 could be attributed due to high level of oat flour used in them, similar results were obtained by Bushway *et al*. (1982) and Chang and

Carpenter (1997), who also reported that the addition of oat bran and potato starch decreases juiciness of frankfurters. Highest juiciness score in T2 could be attributed due to maximum level of soy flour incorporation which entraps fat and water in the products and in turns enhance juiciness. Similar results were observed in beef emulsion sausages incorporated with soybean flour and finger millets enhances juiciness in the product (Behailu and Abebe, 2020). Badpa and Ahmad (2014) also found soy protein isolate incorporated in emulsion sausages slightly improved juiciness, texture and colour.

Overall acceptability score was significantly ($P \leq 0.05$) highest for T3 and least for T1 (Table 5). The nutritional value and overall eating quality of meat products are both enhanced by soy protein (Mozaffarian, 2016). First impression of any meat product is its appearance, which is crucial in determining whether it will be accepted or rejected in its whole. Because they cover up the taste of the meat, non-meat components in meat products typically lower the sensory score. However, when used in moderation, non-meat ingredients can increase yield without significantly ($P \leq 0.05$) affecting consumer acceptability.

CONCLUSION

Consumers are now a days preferring food products which are convenient to make and contains all the necessary nutrients for fulfilling their body requirements. Chevon chunks like products have enormous potential in ready to cook category of food products. Non-meat ingredients play a vital role in preparing such products which not only lowers the cost but also provide necessary nutrients. Chevon chunks prepared with non-meat ingredients like soy flour, oat flour and chickpea flour brings high protein and fibre to the products at very low level of moisture which helps in enhancing the shelf-life of the product. Among all the treatment groups T3 delivered best overall acceptability sensory scores by the sensory panellists. On instrument colour profile also the T3 got least L^* value means the product was darker which enhance the appeal of the products. Therefore, it can be concluded that T3 have potential to be developed as a ready to cook meat product with longer shelf life.

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