

Determination of Quality Properties of Sucuk Produced Using Cattle Head Meat

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Abstract: Sucuk is produced by mixing beef, animal fat and different spices. Usage of head meat, which is relatively more affordable, for sucuk production has started to increase, especially depending on red meat prices. In this study, 100% beef (group A) or 100% cattle head meat (group B) were used for sucuk production. Both groups of sucuk were heat-treated. Microbiological, chemical, sensorial and histological properties were analysed in sucuk. Enterobacteriaceae, coliform bacteria and *Escherichia coli* levels were all <2.00 log CFU/g in both sucuk groups; the numbers of total aerobic bacteria and *Micrococcus/Staphylococcus* were 4.95 log CFU/g and 2.13 log CFU/g in group A; 5.23 log CFU/g and 2.25 log CFU/g in group B, respectively. The pH of group A sucuk was lower than that of group B. Hydroxyproline and connective tissue contents of group B were higher than those of group A. Outer surface lightness value (L) was higher in group A, and redness (a) was higher in group B. Texture analysis showed that group B had higher hardness, cohesiveness and gumminess values, while group A had higher springiness and chewiness values. Striated muscle and adipose tissue were detected in group A, and sero-mucous tissues were found in group B during the histological analysis. Group A sucuk, in the sensory analysis, achieved higher general satisfaction scores than group B. As a result, head meat can be used in sucuk production.

Keywords: sucuk, sausage, beef, cattle head meat.

Introduction

Sucuk is defined as a fermented or heat-treated meat product. The cross-section of sucuk looks like a mosaic due to the fermentation and heat processes, which are applied after mincing and mixing the meat and fat of cattle and/or young cattle with flavours and filling them into natural or artificial casings under specific conditions. There are two types of sucuk in Turkey: fermented and heat-treated sucuk (TFC, 2019). With the increased sucuk production in Turkey, the increase in costs, and the development of competition in processed meat production, traditional sucuk has become increasingly appealing to only selective customers. Therefore, industrial sucuk production has started, and the final product is called heat-treated sucuk (Degirmencioglu et al., 2006). There are many alternative types of sucuk in the world that are produced especially from edible offal, sometimes along with skeletal muscle (Krishnan and Sharma, 1990; Santos et al., 2003; Estévez et al., 2005; Magoro et al., 2012).

Edible parts obtained from the head part of the animals, and that are composed of muscle tissue that do not contain skin, glandular tissues, brain, tongue, lymph nodes, pharynx muscle, mucosa, eye, gristle or bones, are defined as head meat (TFC, 2019). A significant amount of head meat is produced when the number of cattle butchered for human consumption is taken into account. After separating the parts (glandular tissues, bone, gristle etc.) that will not be consumed from the head meat, an average of 4–5 kg of meat can be obtained from an average adult bovine. In addition to its usage as ground meat and fried meat, head meat can also be used in products such as sucuk, salami and sausage in many countries. It seems that the usage of head meat, which is relatively more affordable, has now started to increase, especially depending on red meat prices. Additionally, it is known that sucuk produced from head meat also has a pleasant flavour and aroma. This study aims to determine the characteristics of heat-treated sucuk produced from cattle head meat.

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Materials and Methods

Production of Sucuk

For sucuk production, 80% beef (carcass meat, Group A) and 80% cattle head meat (Group B) was used in the sucuk batter. Sucuk batters were prepared by adding 20% fat and 2% salt (with sodium nitrite, NaNO₂), 0.6% sucrose sugar, 1% dried clean garlic, 0.7% red pepper, 0.5% powdered black pepper, 0.9% cumin and 0.25% pimento. Prepared sucuk batters were filled into 35 mm calibre intestinal casings and rested overnight, then processed by heat treatment for 15 minutes, to a central core temperature of 68°C (Kara and Akkaya, 2010). Analyses were conducted on sausages ready for consumption after production.

Physico-Chemical Analysis

Moisture, protein and fat content analyses of sucuk were performed according to (AOAC, 1990). The pH of sucuk was measured with a pH meter (Orion 420A, United States) standardised using buffer solutions at pH 4 and pH 7. The water activity (a_w) values of the sucuk were measured at 20°C using the a_w device (Novasina Lab-touch, Switzerland). L (lightness), a (redness), b (yellowness) values of the samples (inner and outer surface) were measured using a Minolta colour meter (Minolta CR300 Reflectance Colorimeter, Osaka, Japan). Determination of the level of thiobarbituric acids (TBA) was performed using spectrophotometric measurement (Tarladgis et al., 1960; Shahidi et al., 1985). The amounts of hydroxyproline and connective tissue in sucuk were determined according to TS 6239 ISO 3496 (1997).

Texture Analysis

Hardness springiness, gumminess, cohesiveness, and chewiness features (Microstable TA.XT Plus, US) of sucuk were determined by texture profile analysis (TPA) (Barbut, 2006).

Microbiological Analysis

Sucuk (10 g) was homogenised with 90 ml of sterile peptone saltwater. Then, serial dilutions were prepared from the 1:10 reconstituted homogenates. The presence of *Salmonella* (ISO, 2017a), *Listeria monocytogenes* (ISO, 2017b) and *Escherichia coli* O157 (ISO, 2001) was determined, while counts of total aerobic mesophilic bacteria (TAMB) (ISO, 2013), Enterobacteriaceae (ISO, 2004), coliforms (ISO, 2006), *E. coli* (ISO, 2018a) and *Staphylococcus/Micrococcus* (ISO, 2018b) were determined.

Histological analyses

Histological analyses of sucuk were performed according to Luna (1968).

Sensory analysis

The sensory analysis of the sucuk was conducted by 10 expert panellists who were informed about the general characteristics of sucuks. Panellists evaluated the sucuk using a hedonic scale with a score range: 1–3 (very bad — unacceptable), 4–5 (medium), 6–7 (good), 8–9 (very good) in terms of appearance, colour, taste, texture and overall score (Altug, 1993).

Statistical analysis

Sucuk were produced in three repetitions, and the analyses were performed in two parallels. The difference between the sucuk groups was determined using the t-test.

Results and Discussion

Table 1 shows the findings of microbiological analysis of the two types of sucuk. Additionally, *Salmonella*, *L. monocytogenes* and *E. coli* O157 were not detected in the sucuk produced. The difference in the number of TAMB and in the number of *Staphylococcus/Micrococcus* between groups A and B was significant (p<0.05). Additionally, in both groups, *Enterobacteriaceae*, coliform and *E. coli* levels were <log 2.00.

Table 1. Microbiological Analysis (Family, group or species (mean log CFU/g)) of Sucuk

	TAMBS	Enterobacteriaceae	Coliforms	<i>E. coli</i>	Stap/Mic
A	4.95±0.07	< 2.00	< 2.00	< 2.00	2.13±0.04
B	5.23±0.04	< 2.00	< 2.00	< 2.00	2.25±0.01
	p<0.05	–	–	–	p<0.05

Legend: A: beef; B: cattle head meat; TAMBS: total aerobic mesophilic bacteria; LAB: lactic acid bacteria; Stap/Mic, *Staphylococcus/Micrococcus*

Table 2. Chemical Analysis of Sucuk

	pH	a _w	Moisture (%)	Fat (%)
A	5.65±0.02	0.826±0.013	45.25±0.82	33.46±0.06
B	6.40±0.01	0.837±0.014	41.06±0.33	30.99±0.02
	p<0.05	p<0.05	p<0.05	p<0.05
	TBA	Protein (%)	Hydroxyproline	Connective tissue
A	0.017±0.001	14.90±0.05	0.293±0.02	12.13±0.02
B	0.011±0.003	10.23±0.03	0.904±0.06	34.05±0.03
	p<0.05	p<0.05	p<0.05	p<0.05

Legend: A: beef; B: cattle head meat;; TBA: Thiobarbituric acid

The analysed parameters show the hygienic quality of the prepared sucuk. Thus, the incidence and numbers of Enterobacteriaceae in the head meat are reported as an effective indicator of hygiene and quality, especially concerning contamination of faecal origin (Tornadijo *et al.*, 2001; Carney *et al.*, 2006). Therefore, according to this study, it was determined that if the head meat, used as raw material, is obtained under appropriate conditions, the microbiological quality of the sucuk produced will be good. In our study, the microbiological properties of both groups of sucuk were found to be acceptable. However, Ranken (2000) reported that head meat should be used with caution as it is likely to be infected with a high level of bacteria.

Table 2 shows the results of chemical analysis of the prepared sucuk. Significant differences were found between groups A and B in terms of the analysed parameters (pH, a_w, moisture, fat, protein, TBA, hydroxyproline, and connective tissue) (p<0.05).

Chemical analyses provide important information about the quality and content of meat products. The pH (6.40±0.01) of group B sucuk was higher than that of group A (6.17±0.01). Similarly, Verna *et al.* (2008) found that the pH (6.41) of head meat was higher than that of skeletal muscle (5.85). Verna *et al.* (2008) reported that higher pH may be from head meat.

Considering a_w values of the sucuk, group A was 0.826, while group B was 0.837. a_w values in sucuk reported by Kaban and Kaya (2006) were 0.889–0.902. Coskuner *et al.* (2010) reported levels of 0.924–0.950. The a_w of sucuk in our study was lower than in these other studies.

In sucuk produced in the study, moisture contents were 45.25±0.82% in group A and 41.06±0.33% in group B. Fat content was deter-

mined as 33.46±0.06% in group A and 30.99±0.02% in group B. However, the fat and moisture contents of both groups of sucuk were found to be at acceptable levels according to the *Turkish Food Codex* (2019).

The TBA value of sucuks has a significant effect on colour quality, aroma, texture and nutritional value (Demeyer *et al.*, 2000) In our study, the TBA value was 0.017±0.001 in Group A sucuk and 0.011±0.003 in Group B sucuk (p<0.05). It was earlier reported that the TBA values >1.0 mg/kg cause bad odours (Wu *et al.*, 1991)

In the analysed sucuk groups, the protein content (14.90±0.05%) in the group with carcass meat was higher than in the group with head meat (10.23±0.03%) (p<0.05). Another study reported that the protein content of skeletal muscle is 19.84%; the protein content of head meat is 19.25% (Verna *et al.*, 2008). The study by Dogu *et al.* (2002) found an average protein content of 17.16% in sucuk. According to the Turkish Food Codex, the protein content should be 14% in heat-treated sucuk. The protein content of our sucuk that were produced using head meat did not meet this regulatory requirement.

Hydroxyproline contents were determined as 0.293±0.02 in group A sucuk and as 0.904±0.06 in group B sucuk. A significant difference (p<0.05) was found between the connective tissue level of the two types of sucuk, which were produced using carcass meat (12.13±0.02), or head meat (34.05±0.03). The fact that the head meat used was fibrous, rich in glandular tissues and had a high content of collagen would have impacted the sucuk produced from this meat type, causing low protein and high glandular tissue contents.

Table 3. Colour Analysis of Sucuk

	Inner Surface			Outer Surface		
	<i>L</i>	<i>a</i>	<i>b</i>	<i>L</i>	<i>a</i>	<i>b</i>
A	45.05±0.02	25.58±0.01	19.26±0.01	42.18±0.04	21.33±0.06	13.71±0.02
B	48.93±0.04	25.07±0.02	24.33±0.02	40.25±0.01	23.59±0.01	16.14±0.03
	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05

Legend: A: beef; B: cattle head meat

Table 4. Texture Analysis of Sucuk

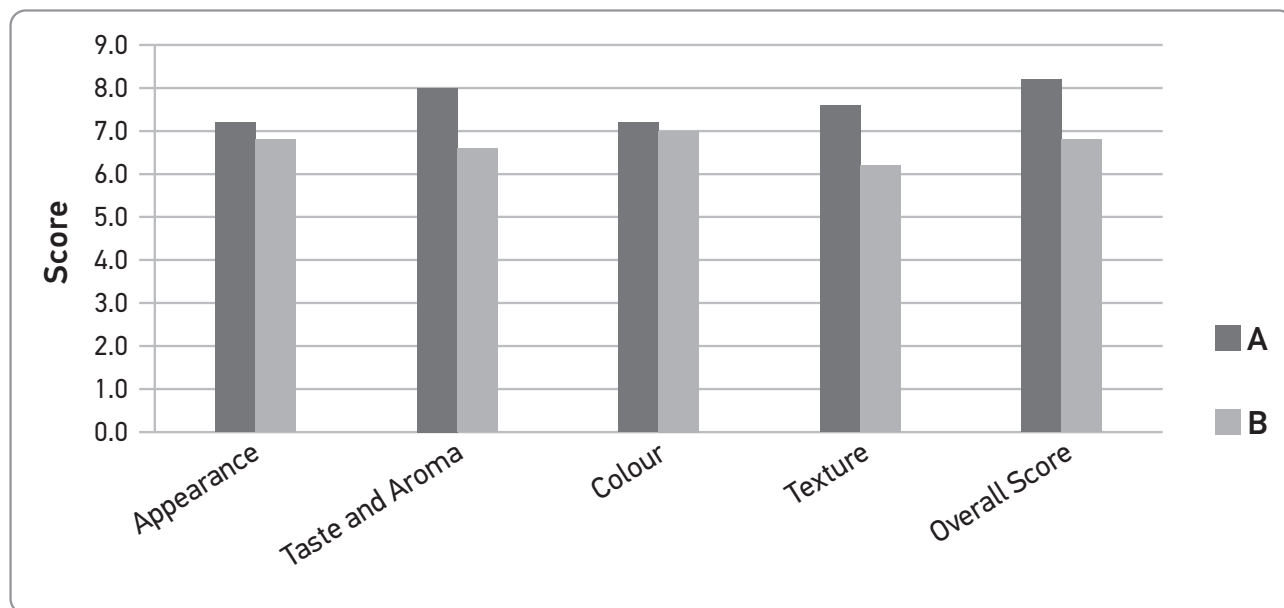
	Hardness	Cohesiveness	Gumminess	Springiness	Chewiness
A	47.04±0.77	0.36±0.03	19.27±1.68	0.87±0.01	16.78±1.73
B	63.71±2.15	0.45±0.01	28.66±0.06	0.74±0.02	21.06±0.57
	p<0.05	p>0.05	p<0.05	p<0.05	p>0.05

Legend: A: beef; B: cattle head meat

In meat products such as sucuk, physical properties, colour and organoleptic properties are the main factors that affect consumer choice. In general, these characteristics are measured by organoleptic techniques (Bozkurt and Bayram, 2006). Table 3 shows the cross-section surface colour and outer surface colour analysis results of the sucuk. A significant difference was observed between the two groups in both

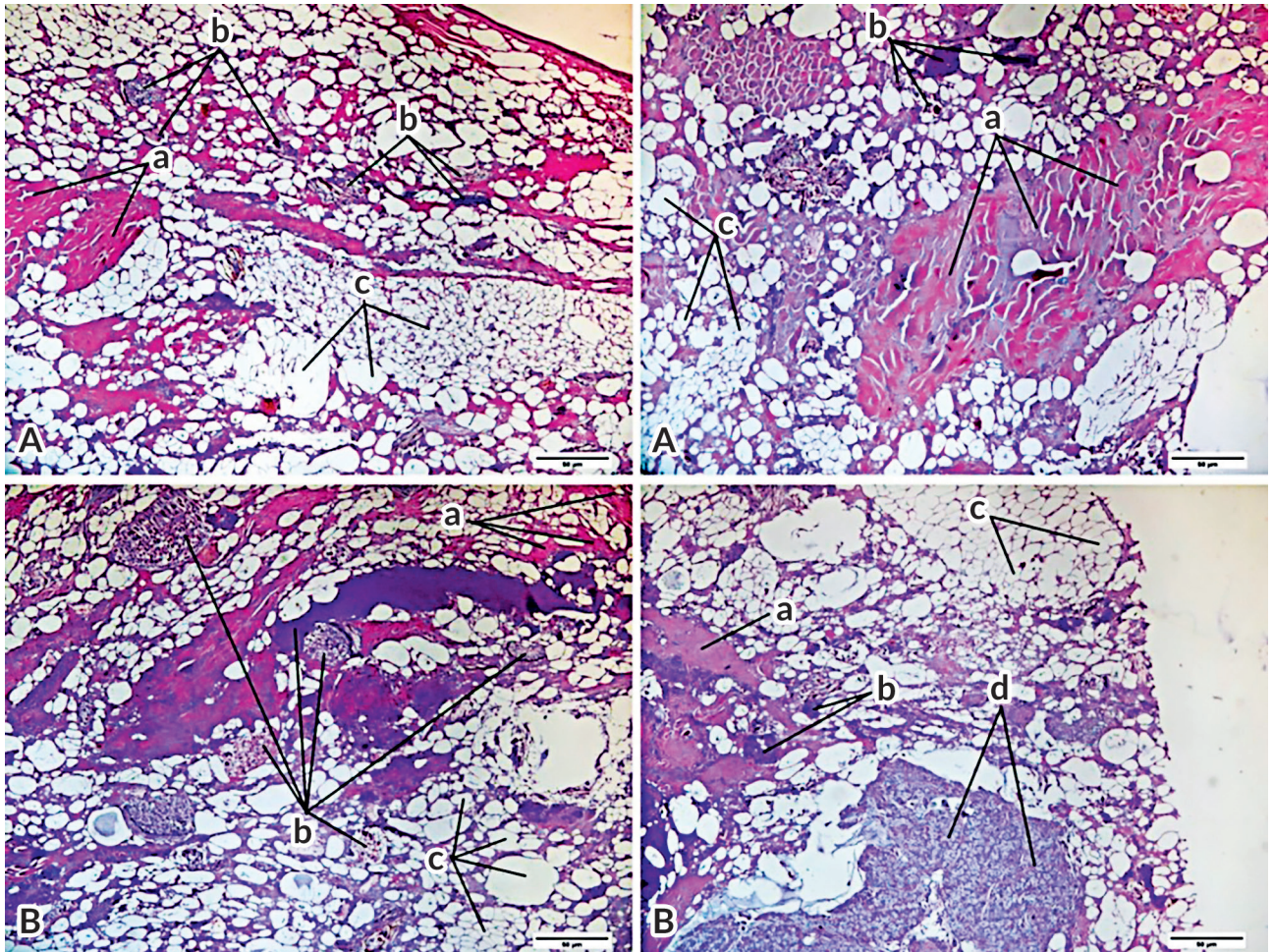
cross-sectional surface colour and external surface colour in terms of redness, yellowness, and lightness (p<0.05).

Table 4 shows the texture analysis results of the sucuk. There was no difference between the two groups in term of cohesiveness (p>0.05), but other differences between groups A and B were found to be significant (hardness, gumminess, springiness and chewiness) (p<0.05).



Legend: A: beef; B: cattle head meat

Figure 1. Organoleptic Analysis of Sucuk



Legend: A: beef; B: cattle head meat; a: skeletal muscle cell, b: spices, c: adipose tissue cell, d: seromucous glands

Figure 2. Histological analysis of the sucuk prepared from beef meat and cattle head meat

In the sensory analysis, no significant differences were found between the two groups of sucuk in terms of appearance and colour characteristics ($p > 0.05$). Although group B scored lower in terms of taste, texture and general taste characteristics than group A, nonetheless, scores for group B were within the acceptable scoring range ($p < 0.05$) (Figure 1).

Histological analyses identified striated muscle, adipose tissue and animal tissue in group A, while group B was found to contain striated muscle, adipose tissue and a small amount of seromucous tissue (Figure 2). During production, head meat should be separated from other tissues in the head: glandular tissue, lymph nodes, mucous membranes, eyes, cartilage and bones. The analyses conducted in the current study showed that this decomposition cannot be fully accomplished.

Conclusion

This study found that sucuks that are produced using head meat are acceptable in terms of microbiological, textural and organoleptic properties. However, sucuk prepared with head meat does not comply with the Turkish Food Codex, especially due to its high collagen content, low protein content and unacceptable hydroxyproline content. In order to evaluate and utilise cattle head meat with regard to high volume cattle production, novel legal arrangements will be necessary in the sucuk production process. It is recommended that all sucuks containing head meat are appropriately labelled for consumers by stating head meat as an ingredient on the product declaration.

Određivanje osobina kvaliteta sudžuka proizvedenog od goveđeg mesa

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Apstrakt: Sudžuk se proizvodi mešanjem goveđeg mesa, životinjske masti i različitih začina. Upotreba mesa od glave, koje je relativno pristupačnije, za proizvodnju sudžuka, je u porastu, posebno u zavisnosti od cena crvenog mesa. U ovom istraživanju, za proizvodnju sudžuka korišćeno je 100% goveđe meso (grupa A), odnosno, 100% meso glave goveda (grupa B). Obe grupe sudžuka su termički obrađene. U sudžuku su analizirana mikrobiološka, hemijska, senzorna i histološka svojstva. Enterobacteriaceae, koliformne bakterije i nivoi *Escherichia coli* bili su <2,00 log CFU/g u obe grupe sudžuka; broj ukupnih aerobnih bakterija i *Micrococcus/Staphylococcus* bio je 4,95 log CFU/g, i 2,13 log CFU/g u grupi A, odnosno, 5,23 log CFU/g i 2,25 log CFU/g u grupi B, respektivno. pH vrednost sudžuka grupe A bio je niži nego u grupi B. Sadržaj hidropsiprolina i vezivnog tkiva u grupi B je bio veći nego u grupi A. Vrednost za boju spoljašnje površine (L) bila je veća u grupi A, a crvena boja (a) je imala veće vrednosti u grupi B. Analiza teksture je pokazala da je grupa B imala veće vrednosti tvrdoće, kohezivnosti i gumavosti, dok je grupa A imala veće vrednosti elastičnosti i žilavosti (žvakanje). U grupi A detektovani su poprečno-prugasti mišići i masno tkivo, a u grupi B, sero-mukozna tkiva, koja su utvrđena tokom histološke analize. Sudžuk grupe A je u senzornoj analizi postigao više ocene opšte prihvatljivosti/zadovoljstva proizvodom od grupe B. Kao rezultat toga, meso glave goveda se može koristiti u proizvodnji sudžuka.

Ključne reči: sudžuk, kobasica, goveđe meso, meso glave goveda.

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