



# International Journal of Veterinary Science & Technology

## Review Article

# Characteristics of Traditional Turkish Fermented Soudjouk and Current Situation -

**Bulent Nazli\***, Halime Pehlivanoglu and Muhammed Y. Caglar

*Istanbul Sabahattin Zaim University Food Engineering Department, Faculty of Engineering and Natural Sciences, Istanbul, Turkey*

**\*Address for Correspondence:** Bulent Nazli, Istanbul Sabahattin Zaim University, Food Engineering Department, Faculty of Engineering and Natural Sciences, Halkali Cad. No:2, 34303, Kucukcekmece, Istanbul, Turkey, Tel: +90-212-692-97-07; Fax: +90-212-418-68-15, E-Mail: bulent.nazli@izu.edu.tr

**Submitted:** 21 July 2017; **Approved:** 28 July 2017; **Published:** 13 September 2017

**Citation this article:** Nazli B, Pehlivanoglu H, Caglar MY. Characteristics of Traditional Turkish Fermented Soudjouk and Current Situation. Int J Vet Sci Technol. 2017;1(1): 013-019.

**Copyright:** © 2017 Nazli B, et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.



## Abstract

In this review study, it is aimed to give an information about the current situation and characteristics of the Traditional Turkish Fermented Soudjouk which has been known since ancient times and consumed with appreciation by the people of our country.

For this reason, the information was gathered on the importance for health and nutrition of traditional Turkish fermented soudjouk and its production technology, sensory, physico-chemical, microbiological characteristics and its current situation and was given in accordance with a certain plan.

According to this, in soudjouks produced without heat treatment, it was determined that its characteristics which subject consumer liking of soudjouk was formed the result of fermentation that occurred in completely natural conditions.

In parallel with the information gathered, it has been concluded that the traditional Turkish Fermented soudjouk is a useful product for nutrition and health due to valuable nutrients and probiotic microorganisms included and so the presence of the product should be protected and its geographical marking as a national product should be made in Turkey.

**Keywords:** Fermentation; Soudjouk (Sucuk); Ripening; Starter Culture; Probiotic

## INTRODUCTION

In food technology, food production and preservation methods such as fermentation, fumigation, drying and salting have been used for years to conserve food and consume more varied flavors and aromas [1].

The fermentation is a natural method that enhancing the nutritional value of foods by the synthesis of essential amino acids and vitamins and it is a metabolic process that there energy is release biochemically with partially oxidized of carbohydrates and related compounds in the absence of any electron acceptor [2].

Traditional Turkish Fermented soudjouk is a fermented meat product produced usually in the autumn season, by adding animal fat, spices, garlic and salt to cattle and buffalo meat, after thoroughly mixing, filled into natural intestines and left to natural fermentation for 15-20 days [3,4].

During fermentation under natural conditions the natural microflora of meat, fat and spices origin evolves over time depending on ambient conditions and causes to shape the desired properties specific to fermented soudjouk due to the enzymatic activities of microorganisms [5]. In particular, the natural taste, odor, flavor and aroma characteristics formed by fermentation are greatly appreciated by the consumers and increase the demand for the product. In the studies on fermented soudjouk ripened under natural conditions, it was determined that lactobacilli, micrococci, pediococci and some molds and yeasts were dominant in fermented soudjouks [6-8].

These microorganisms started to be used as starter cultures and probiotics in fermented products due to their desirable characteristics [9]. In fermented soudjouks, it is reported that Lactobacilli is effective directly in pH reduction and aroma formation and indirectly color formation with lactic acid making up, Micrococci and staphylococci play a role in the formation of color and aroma by reducing the nitrate. Therefore, in many countries these microorganisms are used extensively as starter cultures, to control fermentation in soudjouks, shorten the ripening period, and obtain product of standard type and quality at the desired level [10]. It has been determined that the lactic acid bacteria commonly detected in Turkish soudjouks are *L.sakei*, *L. plantarum*, *L.curvatus* and *L. Brevis* [11,12].

In Turkey, despite the production of natural soudjouk is wide spread, the production is usually carried out in small-scale enterprises. On the other hand, medium and large scale enterprises prefer to produce semi-fermented soudjouks or the soudjouk-like

products heat-processed due to high production cost and longer time. Some companies are selling heat-processed soudjouk-like products to the market with a natural fermented soudjouk label, which causes consumer deception due to product imitation and adulteration [13].

The consumers are looking for natural flavors that they like and are used to. If the fat composition is well adjusted, the natural fermented soudjouk is a valuable meat product in nutrition due to its useful microorganisms and its metabolism products that are contained. However, in recent years, the Traditional Turkish Fermented Soudjouk has been reduced to extinction due to the rapid development of technology and the increase in population [14,15].

This review study was carried out with the aim of revealing the characteristic of the Traditional Turkish Fermented Soudjouk consumed in Turkey and its current situation.

## DEFINITION AND IMPORTANCE OF TRADITIONAL TURKISH FERMENTED SOUDJOUK

Traditional Turkish fermented soudjouk is a fermented meat product that is produced by simply drying soudjouk under natural conditions without using starter cultures or heat treatments [16]. Generally, it is mostly produced in the autumn months when the air temperature, air flow and humidity are most suitable. It is filled with natural spices, salt and sugar into the meat-fat mixture and then ripened by natural fermentation and dried for 15-20 days in the open air [6,12,17].

According to Turkish Standards Institute (TS-1070), Turkey, soudjouk is defined as a traditional meat product for which, thermal processing is not applied. The major steps in this process include the separation of fat, bone, tendon, fascia, cartilage, lymph ovules and large nerves and veins from bovine and ovine meat, (ii) mincing by meat grinder or cutter, (iii) addition of salt, red pepper, black pepper, cumin, a variety of spices, condiments, starter cultures, body fat, internal fat, tail fat, kidney fat and one or more additives that are allowed by the legislation (iv) to be mixed into minced meat and filled in natural and artificial intestine casing and subjected to fermentation [18].

According to the Turkish Food Codex Meat and Meat Products Communique, the fermented soudjouk is defined as a fermented meat product which is not heat treated and its cross-section is of mosaic appearance. In these products minced bovine and/ or ovine meat and/ or fats are mixed with flavorings and are filled into the natural or

artificial casing and the humidity is reduced to 40% or less through controlled fermentation and drying process [19].

These definitions are not specific to the Traditional Turkish Fermented Soudjouk and generally specify all sausages/soudjouks produced in Turkey. There is still no standard for traditional Turkish fermented soudjouk and in our opinion, legal regulations on meat products are insufficient. On the other hand, there are published scientific studies on Traditional Turkish Fermented Soudjouks in Turkey [10,20-24].

Fermented soudjouks constitute a significant portion of ready to serve meat products in our country and their share in meat products is approximately 42% in the market which demonstrates the importance of fermented soudjouks in the diets of Turkish people [25].

The soudjouks produced by natural fermentation have superior properties compared to the soudjouks produced by controlled fermentation using industrial starters. The reason for this is the quality of the raw meat used, the nature of the technology used and the specific structure of the natural flora [5,26].

Fermented soudjouks produced by natural fermentation without heat treatment are nutritionally valuable due to their high quality protein contents, B group vitamins, minerals, trace elements and other bioactive compounds [27]. The technological processes applied to meat products, especially heat treatments, can reduce the nutritional value of meat products by reducing the bioavailability of amino acids [28].

Fermented soudjouks in addition to their nutritive properties are considered probiotic meat products due to the beneficial bacteria they contain. Probiotic meat products are among the health-related products which have increasing importance in today's food sector. These products have positive effects on health as well as features such as imparting flavor and aroma to the product, improving physical structure and influencing on microbiological flora [29].

Probiotics are defined as live microorganisms that, when taken at a sufficient level, have positive effects on host health and provide microbial balance of the intestinal tract [30,31]. The dominant microflora of the traditional Turkish Fermented soudjouks is Lactobacilli that is being accepted as the most important probiotic. Lactobacilli that develop in completely natural conditions has great importance for product safety and consumer health. The studies are conducted to protect these microorganisms against adverse effects of external influences and stomach digestion conditions [11,32,33].

On the other hand, in natural conditions, it is difficult to reproduce soudjouk of the same quality and standard. Moreover, due to the increasing population, technological developments and increases in demand, soudjouk production in the standard and the same quality has become mandatory in every season of the year [34].

Consequently, the production of heat treated soudjouk-like products, which has a low production cost and short production time, has become very popular in Turkey due to the ever increasing demand from the consumers [15,35].

These emulsified products are subjected to heat treatment without using starter cultures and by the addition of some chemical substances. They can be presented to the market within 2-3 days as soudjouk-like products. In fact, these products are sausages and salami which artificially gained sensory qualities of fermented soudjouk. The consumers can choose these products knowing they

were not naturally produced which are also more economically available in the market place [13,36].

However, some companies are launching these products to the market with the more expensive and more desirable fermented soudjouk label which lead to consumer deception. In addition such companies taking risks in terms of health due to imitation and adulteration.

For example, in a study conducted by Pehlivanoglu et al. [13] 30 soudjouk samples present in the Istanbul market with fermented soudjouk label were examined and it was determined that 8 samples (26.6%) were fermented soudjouk products, 9 samples (30%) were semi-fermented and 13 samples (43.3%) were heat-treated non-fermented soudjouk in terms of sensory, physico-chemical and microbiological properties.

On the other hand, in this study, it was observed that soudjouks produced using starter culture did not fully reflect the characteristics of traditional Turkish fermented soudjouk. Because these soudjouk were produced in a shorter time using starter culture and heat treatment. In general, they are transformed into different products in terms of flavor characteristics and health implications when compared to traditional Turkish fermented soudjouk.

In this sense, in the first meat products "Sucuk" workshop report made in 2010, it was expressed that the heat-treated soudjouk-like products caused unfair competition among producers, that these products could mislead the consumer and that legal regulations and standards about soudjouks were not clear and sufficient. Finally, the reports stated that the inspections were inadequate and the legislation was interpreted differently by different units of government and companies [15].

## PRODUCTION TECHNOLOGY OF TRADITIONAL TURKISH FERMENTED SOUDJOUK MEAT AND FAT CHOICE

Cattle and buffalo meat kept under proper conditions and slaughtered when the animals were between the ages of 6-8, are generally used in production of fermented soudjouk. The carcasses that are obtained after slaughtering are stored at + 4°C for 48 hours. The pH value is reduced around the isoelectric point (pH 5.2-5.6) and meat is separated from bone. After ward, the meat parts are kept in cold storage at 80% relative humidity and at + 1°C temperature for 24 hours [12,37]. The obtained meat has low water retention properties, a lighter aroma and high coloring ability and have a pale and tight appearance [38].

Further addition of meat fats from other stokes is also carried out to increase the fat content of fermented soudjouks. For this purpose, body fat, inner fat, tail fat and kidney fat or mixtures there of are added to soudjouk at a rate of 20-40% [39]. The fat that are added to the fermented soudjouk are the ones that are added from the outside except the fat containing the meat. For this purpose, body fat, inner fat, tail fat and kidney fat or mixtures are added to soudjouk at a rate of 20-40% [39].

### Soudjouk paste preparation and filling

The meat, which is used in preparing the soudjouk, is removed from the rough fat that is observed after separation from the bones. Then, it is cut into pieces the size of 6 x 8 cm and stored in cold storage for 8-12 hours at 0-4°C. The meats lose some of their weight due to the loss of water during the storage period. At the end of storage, first the

meat and fats pass through the meat mincer and then meat, fat and spices are properly mixed [12,37].

Spices added to the soudjooks include red pepper (0.5-0.6%), black pepper (0.3-0.7%) and cumin (0.6-1.5%), garlic (0.4-1%), sugar (0.4-1%), salt (2.0-3.2%). Legal limits for nitrate (0.025%) and nitrite (0.015%) addition also have to be followed. The obtained soudjook paste is kept in cold storage at 0-4°C for 1 day [39].

The prepared soudjook paste is filled into small intestines of cattle, and after the connection of the ends of the covers and small holes are opened to the cover surface for evaporation of water during drying [12].

### Fermentation and ripening

After the filling process, the soudjooks are hanged in open areas called "Cardak" during autumn where they are exposed to heat (10-15°C), humidity (80-90%) and wind (1-1,5 m/ sn). Here, for 15-20 days, soudjooks gradually dry out, and the ripening during microbial fermentation influences both internal and external characteristics of the product [8, 21].

The drying in soudjooks takes place from inside to outside where the water comes out partly by the diffusion and partly from the small canals between the rough texture particles of soudjook paste. The presence of ducts that provide drying in soudjooks depends on the amount of fat added and on the temperature of the meat and the fat as well as the sharpness of the instruments used for meat grinding [38,39].

The quality and storage stability of the fermented soudjooks is largely dependent on their moisture content that has been properly lost during ripening. The degree of drying rate, the content and degree of mincing the soudjook paste, the thickness of the soudjook coil, the temperature, humidity and air current applied during ripening are factors that influence the soudjook quality [12].

In fermented soudjooks the ripening is characterized by the aroma, flavor, color and consistency characteristics which are developed as a result of the biochemical reactions formed by the enzymes of various microorganisms [5,7,40].

The presence of a desired microflora in fermented soudjooks is required for biochemical reactions. The role of these desired microorganisms in soudjook ripening, are to create color, to reduce the pH, degrading the glycogen present in the meat, to provide an acidic environment, to form aroma and flavor degrading fats and to prevent the development of undesirable bacteria [17,41-43].

## CHARACTERISTICS OF TRADITIONAL TURKISH FERMENED SOUDJOOK

Characteristics of fermented soudjooks consist of a series of biochemical, microbial, physical and sensory changes that occur during soudjook ripening at a certain relative humidity, temperature and air flow conditions [44,45].

These changes, which are the result of fermentation, are defined as pH decrease, microflora change, reduction of nitrate to nitrite and nitrosomyoglobin formation, increased solubility and gelation of myofibrils and sarcoplasmic proteins, proteolytic, lipolytic and oxidative changes and acidification resulting from dehydration [43,46-48].

### Sensorial properties

In traditional Turkish fermented soudjooks, the sensory properties such as appearance, color, consistency, cross-section, flavor and aroma are shaped depending on the applied technological processes and the microbial activities that occur during fermentation [49,50].

The soudjook paste filled in the intestines should be in homogeneous appearance, there should be no folds, molds, salt stains and bacterial spots on the outer surface of the soudjook casing. Especially fats should not flow out from the intestines. Good mixing of meat, fat and other materials in the soudjook and proper filling of the intestines gives a homogeneous appearance and a smooth cross-section character [51].

A ripe soudjook has a normal red meat color, and this color should be the same on the outer surface and along the cross-section of the fermented soudjook. Nitrite and nitrate, which are used according to the legal limits play an important role in colour formation and stabilization. These chemical substances provide reliability in soudjooks. The formation of color in soudjooks is due to the reduction of nitrate to nitrites by bacteria and the formation of Nitroso-Myoglobin (NOMb) by combining the formed NO with myoglobin in the meat. Red pepper and sugar contribute to the desired colouring of soudjooks [12,52].

The consistency of fermented soudjook should be medium; not too hard or too soft. For this reason, the meat used in production must be ripe meat and the meat fat mixture must be well-adjusted and well-chilled. In addition, a hard ring should not occur on the soudjook surface which is an indication of drying faults. Fermented soudjooks should be easy to cut and the cross-section must be smooth. The fat on the cross section must be homogeneously dispersed and demonstrate marble-like appearance [26,51].

The flavour and aroma properties of fermented soudjooks due to formation of numerous volatile and non-volatile components during microbial fermentation. Amino acids, peptides, carbonic acid, sugar and their vicissitudes and organic salts are considered non-volatile aroma substances. Most of these compounds are considered to be the precursors of the volatile aroma substances that will be formed later towards the end of fermentation [46,53-55].

Spices such as red pepper, black pepper, cumin and garlic, and additives such as salt and sugar which are added to soudjook paste play an important role in the formation of typical taste and aroma [12,39].

### Physico-chemical properties

During the first days of fermentation, the pH value of the fermented soudjook is between 5.6 and 5.8. due to the breakdown of carbohydrates by bacteria, the pH drops to 4.8-5.0. Likewise, in the first days of drying, the humidity 65-70% decreases gradually by 25-30% and drops to about 40% [12,56].

According to Turkish Standards Institute, TS-1070, pH value of Turkish soudjook is between 4.7-5.4% and moisture content maximum is 40%, while the fat content can be up to 30% for the first grade, and up to 40% for the second grade. Protein concentration can be up to 20% for the first grade and up to 18% for the second grade [18].

According to Turkish Food Codex Meat and Meat Products



Communique, it is necessary that the total protein mass of soudjouk is at least 16%, the amount of collagen is not more than 20% by mass of total meat proteins, the ratio of the amount of moisture to the total amount of meat protein is less than 2.5, the ratio of the amount of fat to the total amount of meat protein is less than 2.5 and the highest pH value is 5.4 in fermented soudjouks [19].

In a study conducted by Oksuztepe, et al. [23] on 100 fermented soudjouk samples sold in Elazig, it was determined that the average pH value, the amount of moisture, the amount of fat, and the amount of protein were 5.18, 38.75%, 35.22% and 21.92%, respectively. Similarly; in a study conducted on 30 fermented soudjouk samples sold in Konya, it was determined that the average pH value, the amount of moisture, the amount of fat, and the amount of protein were 5.24, 29.49%, 30.9%, 22.73%, respectively [20].

In a study on soudjouks produced by classical type and heat treatment, it was determined that the mean amount of moisture was 50-55% in heat treated and 45% in fermented soudjouk, the fat amounts in heat treated soudjouk 36% and fermented soudjouk 35%, the protein amounts in heat treated % 28 and 28% in fermented soudjouk [14].

### Microbiological properties

The basis of fermented soudjouk production are the microorganisms, and the microflora detected in the soudjouk reveals the microbiological quality. These microorganisms contribute to the formation of desirable sensory properties such as taste, aroma and color of the soudjouk with their metabolic products [5,22,48,57]. The biochemical activities of microorganisms such as lactobacilli, staphylococci, micrococci, molds and yeasts are important in the formation of these fermented soudjouk characteristics [12,39].

In studies on fermented soudjouk, it was determined that the total aerobic mesophile microorganisms, coliform microorganisms, lactic acid bacteria, *Micrococcus*, *Staphylococcus*, mold and yeast constitute the microflora of soudjouks [10,20,21,23,24]. According to Turkish Food Codex Meat and Meat Products Communique, fermented soudjouks should not contain *Salmonella*, *Listeria monocytogenes* and *E. coli* O157: H7 at 25 grams of the sample [19].

In many studies, the total number of aerobic microorganisms in fermented soudjouks is reported to be between  $10^6$  and  $10^7$  cfu/ g [22,12]. However, it is necessary to know from which microorganisms qualitatively the microflora detected in the samples are formed and whether they are desirable microorganisms to be present in fermented soudjouk [40,58].

Coliform group microorganisms which are members of Enterobacteriaceae, indicate a possible cross-contamination during production. These microorganisms produce lactic acid from carbohydrates, convert nitrates to nitrites and break down proteins [39]. However, these microorganisms are also an indication of poor hygiene and technological faults in riped and launched fermented soudjouks. Therefore, coliform microorganisms should not be at high numbers in soudjouk [6,12].

In the fermentation and ripening stages lactic acid bacteria firstly lower the pH value by converting glucose to lactic acid, thereby causing the inhibition of pathogens and undesirable bacteria on the one other hand causing the formation of the typical organoleptic properties of the fermented meat products [11, 59].

It is known that the dominant flora is generally lactobacilli

[7,33]. The salt added to the soudjouk paste and the high ripening temperature cause a decrease in water activity as a result lactobacilli dominate the microflora. This decreases the soudjouk pH value while the taste and aroma are also affected [8,39,59].

Likewise, micrococci and staphylococci are responsible for the development of color by reducing nitrate to nitrite, at the same time they are also effective in the development of aroma in fermented meat products due to their lipolytic and proteolytic activities [60]. Micrococci and staphylococci that can survive at high salt and CO<sub>2</sub> values at low pH and water activity values are associated with lactobacilli during ripening and contribute to the formation of color and aroma in soudjouks [10,41,56,60].

In the first days of ripening, the number of molds and yeasts increases rapidly and the number reaches up to  $10^6$  cfu/ g depending on the environmental conditions. In the following days, the number of molds and yeasts is decreasing towards the end of ripening with decreasing pH, water activity and redox potential values, and they concentrate towards the outer parts of the soudjouk [6,8,12]. While some types of mold and yeast have an effect on color, aroma and odor properties in soudjouks, other types could lead to spoilage [39,61].

In a study conducted by Nazli [12] fermented soudjouk were produced without starter cultures and it was determined that the average number of total mesophilic aerobic microorganisms was  $5 \times 10^6$  cfu/ g, the number of coliform microorganisms was  $3 \times 10^3$  cfu/ g, the number of *Staphylococcus* was  $2,4 \times 10^4$  cfu/ g, the number of *Lactobacillus* was  $1,3 \times 10^6$  cfu/ g and the number of mold and yeast  $1,2 \times 10^4$  cfu/ g.

Similarly, in another study on 30 soudjouk samples obtained from the Konya market by Atasever, et al. [20] the average total aerobic microorganism, coliform group microorganism, micrococci-staphylococcus and mold-yeast counts were reported as  $5.7 \times 10^6$ ,  $7.4 \times 10^3$ ,  $3.2 \times 10^5$  and  $6.4 \times 10^4$  cfu/ g, respectively.

### CONCLUSION

Traditional Turkish fermented soudjouk is a fermented meat product that is produced without heat treatment or starter cultures. Fermented soudjouks are dried and ripened under completely natural conditions.

However, in such soudjouks, the structure, taste and other characteristics may be different from each other and it is not always possible to produce products with the same characteristics. In addition, due to increasing world population, technological developments and increasing demand, meat products with standardized properties has become mandatory in every season of the year. For this reason, in efforts to standardize the products produced by traditional methods have gained momentum [9,34].

Today, many countries in the world continue to utilize natural fermentation without the use of starter cultures by small businesses [62]. In the same way, traditional Turkish Fermented soudjouk production in Turkey is only carried out locally in some small enterprises and is therefore it has become extinct.

It is possible to make this product more useful in terms of food safety and consumer health by optimizing the bioactive functions of probiotic bacteria which are very important for public health in Turkish fermented soudjouks and strengthening them against adverse effects of external influences and stomach digestion conditions [16,63].



In accordance with the information given above, fermented soudjouks produced according to the specified procedures, the following results have been reached. The sensory properties such as color, consistency, taste and aroma that are preferred by consumers develop during ripening with microbial fermentation. Due to having low pH and low water activity values which occurs due to the ripening process, fermented soudjouk is a reliable product and has a long shelf life.

In ripe soudjouks, lactobacilli can demonstrate probiotic properties and dominate to the microflora. Therefore fermented soudjouks should be considered as a probiotic meat product. In Turkey, there are very modern and high capacity facilities which were built in accordance with global standards. In these facilities, it is possible to produce soudjouks in a shorter time by using starter cultures unique to Turkish fermented soudjouk, by controlled fermentation and drying.

Therefore, it is necessary that the traditional Turkish Fermented soudjouk characteristics should not be lost, the production of this product be encouraged, developed and popularized. Finally, geographical marking of soudjouk needs to be completed rendering fermented soudjouk a national product.

## ACKNOWLEDGEMENTS

We would like to thank to Assistant Professor. Dr. Ibrahim Gulseren and Researcher Assistant Marin Neio Demirci from Istanbul Sabahattin Zaim University, Istanbul, Turkey because they have reviewed the manuscript and agreed with the content.

## REFERENCES

- Tamang JP, Kailasapathy K. Fermented Foods and Beverages of the World. CRC Press, New York, United States of America. 2010. <https://goo.gl/sxuHkn>
- Kabak B, Dobson AD. An Introduction to the Traditional Fermented Foods and Beverages of Turkey. *Crit Rev Food Sci Nutr.* 2011; 51: 248-260. <https://goo.gl/aGJ67r>
- Ince K. Dry fermented sausages. *Meat Sci.* 1998; 49: 169-177. <https://goo.gl/Pm22sT>
- Nazli B. Investigation of the Effect of a Starter Cultural Composition Obtained from Turkish Fermented Sausages on the Quality of Sausages. *Journal of Istanbul Univ Vet Fac.* 1995; 21: 217-231. <https://goo.gl/bdj8MS>
- Talon R, Leroy S, Lebert I. Microbial ecosystems of traditional fermented meat products: The importance of indigenous starters. *Meat Sci.* 2007; 77: 55-62. <https://goo.gl/XaLizz>
- Inal T. Bacteriological quality and microbiological standardization of Turkish fermented sausage. *Journal of Bornova Veterinary Research Institute.* 14: 95-103.
- Lucke FK. Fermented sausages. *Microbiology of Fermented Foods.* 1985; 2: 41-83.
- Tekinsen OC, Dincer B, Kaymaz S, Yucel A. Changes in microbial flora and organoleptic qualities during the maturation of Turkish soudjouk. *Journal of Ankara Univ Vet Fac.* 1982; 29: 111-130. <https://goo.gl/C8DTPL>
- Rocha MJ, Elias MN. Quality Improvement of Traditional Dry Fermented Sausages Based on Innovative Technological Strategies. *BAOJ Nutrition.* 2016; 2: 1-4. <https://goo.gl/mXZ05z>
- Dincer B, Ozdemir H, Mutluer B, Yagli O, Erol I, Akgun S. Isolation, identification and production of starter culture bacteria specific to Turkish fermented sausage. *Journal of Ankara Univ Vet Fac.* 1995; 42: 285-293. <https://goo.gl/x8rB8k>
- Gurakan GC, Bozoglu TF, Weiss N. Identification of Lactobacillus strains from Turkish style dry-fermented sausage. *LWT-Food Science and Technology.* 1995; 28: 139-144. <https://goo.gl/mHqD7D>
- Nazli B. Researches on the ripening of Turkish Fermented Sausage using a local starter culture combination. *Tr. J. of Veterinary and Animal Sciences.* 1998; 22: 393-397. <https://goo.gl/h6pP7H>
- Pehlivanoglu H, Nazli B, Imamoglu H, Cakir B. Determination of Quality Characteristics of Products Sold as Fermented Sausage in the Market and Comparison with Traditional Turkish Fermented Sausage. *J Fac Vet Med Istanbul Univ.* 2015; 41: 191-198. <https://goo.gl/SH9T1X>
- Idgirmencioglu MA, Gokgozoglul, Tavsanli H. A Research on Determination of Changes in Properties of Sausages Ripened by Classical Type and Heat Treatment. *Turkey 9th Food Congress. Balikesir Univ Susurluk Vocational High School, Susurluk, Balikesir.* 2006; 24-26.
- Serdaroglu M I. Meat Products "Sucuk" Workshop Report. I. Meat Products "Sucuk" Workshop. 2006
- Rouhi M, Sohrabvandi S, Mortazavian AM. Probiotic Fermented Sausage: Viability of Probiotic Microorganisms and Sensory Characteristics. *Crit Rev Food Sci Nutr.* 2013; 53: 331-348. <https://goo.gl/DMTnyx>
- Ensoy U, Kolsarici N, Candogan K, Karslioglu B. Changes in biochemical and microbiological characteristics of turkey sucuks as affected by processing and starter culture utilization. *Journal of Muscle Foods.* 2010; 21: 142-165. <https://goo.gl/g3nTwb>
- Anonim (2012a) Turkish Sausage TS1070. Turkish Standards Institute, Ministries, Ankara.
- Anonim (2012b) Turkish Food Codex Meat and Meat Products Communiqué (Communiqué No. 2012/74) Official Gazette, 28488, Ministry of Food, Agriculture and Livestock, Ankara.
- Atasever M, Keles A, Guner A, Ucar G. Some quality features of fermented sausages served for consumption in Konya. *Journal of Veterinary Science.* 1998; 14: 27-32.
- ERCOSKUN Hudayi, oZKAL Sami Gokhan. Kinetics of traditional Turkish sausage quality aspects during fermentation. *Food Control.* 2011; 22: 165-172. <https://goo.gl/UQR91x>
- Erdogru o, Ergun o. Some physical, chemical, sensory and microbiological characteristics of sausages consumed in Kahramanmaraş market. *Journal of Istanbul Univ Vet Fac.* 2005; 31: 55-65. <https://goo.gl/TeF96m>
- Oksuztepe G, Guran Hs, Incili GK, Gul SB. Microbiological and Chemical Qualities of Fermented sausages Served at Elazig. *Journal of Firat Univ Vet Health Sciences.* 2011; 25: 107-114.
- Sancak YC, Kayaardi S, Sagun E, Isleyici o, Sancak H. Investigation of the physical, chemical, microbiological and organoleptic qualities of fermented Turkish sausages served in Van province market. *Journal of 100th year Univ Vet Fac.* 1996; 7: 67-73.
- Erdogru oT. Existence of Yersinia enterocolitica in salami and sucuk. *Journal of Biotechnology.* 2000; 24: 75-79.
- Soyer A. Effect of fat level and ripening temperature on biochemical and sensory characteristics of naturally fermented Turkish sausages (sucuk). *European Food Research and Technology.* 2005; 221: 412-415. <https://goo.gl/GUfein>
- Toldra Vilardell F, Reig Riera MM. Innovations for healthier processed meats. *Trends in Food Science and Technology* 2011; 22: 517-522. <https://goo.gl/zwPdgU>
- Kolozyn-Krajewska D, Dolatowski ZJ. Probiotics in fermented meat products. *Acta Sci Pol Technol Aliment.* 2009; 8: 61-74. <https://goo.gl/DBnKqP>
- Sena Ozbay Dogu, Cemalettin Saricoban. Probiotic Meat Products and Nutrition. *Journal of Turkish Agriculture-Food Science and Technology.* 2015; 3: 183-189. <https://goo.gl/aPdu2k>
- Basyigit G, Karahan AG, Kilic B. Functional starter culture and probiotics in fermented meat products. *Journal of Turkish Hygiene and Experimental Biology.* 2007; 64: 60-69.
- Palamutoglu R, Kasnak C. Probiotic Use in Fermented Meat Products Production. *Journal of Turkish Agriculture-Food Science and Technology.* 2014; 2: 208-213.
- Lücke FK. Utilization of microbes to process and preserve meat. *Meat Sci.* 2000; 56: 105-115. <https://goo.gl/q9957c>



33. Vignolo GM, Ruiz Holgado AP, and Oliver G. Acid production and proteolytic activity of *Lactobacillus* strains isolated from dry sausages. *Journal of Food Protection*. 1988; 51: 481-484. <https://goo.gl/whj53D>
34. Gonulalan Z, Arslan A, Kose A. The effects of different starter culture combinations on fermented sausages. *Turkish J Vet Anim Sci*. 2001; 28: 7-16.
35. Anonim (2007) Sucuk Similar Meat Product: Heat Processed Sausage TS 13297. Turkish Standards Institute, Ministries / Ankara.
36. Ercoskun H. The effect of fermentation time on some quality characteristics of sausages produced by heat treatment. Doctoral Thesis. Ankara University Institute of Science, Ankara. 2006.
37. Yildirim Y, Ulgen MT and Ozeren T. Research on Production Methods of Domestic Sausages. *Journal of Ankara Univ Veterinary College*. 1978; 15: 85-98.
38. Gokalp HY, Kaya M, Zorba O. Meat Products Processing Engineering. Ataturk University Publication, Erzurum, Turkey. 1994.
39. Yildirim Y. Meat Industry. (4<sup>th</sup> edn), Kozan of set Matbaacilik, Ankara, Turkey. 1996.
40. Dalmis U. Microbiological and biochemical changes during sausage production and storage. Doctoral Thesis. Ankara University, Institute of Science and Technology. Department of Food Engineering Ankara. 2007.
41. Hammes WP, Knauf HJ. Starters in the processing of meat products. *Meat Sci*. 1994; 136: 155-168. <https://goo.gl/U3jTCi>
42. Huang Lu, Huan Yanjun. Effects of combined starter cultures on quality of fermented sausage during ripening. *Journal of Food Engineering and Technology*. 2016; 5: 38-47. <https://goo.gl/g7c2xW>
43. Ordenez JA, Hierro EM, Bruna JM, de la Hoz L. Changes in the components of dry-fermented sausages during ripening. *Crit Rev Food Sci Nutr*. 1999; 39: 329-367. <https://goo.gl/27kXhv>
44. Dalmis U, Soyer A. Effect of processing methods and starter culture (*Staphylococcus xylosus* and *Pediococcus pentosaceus*) on proteolytic changes in Turkish sausages (sucuk) during ripening and storage. *Meat Sci*. 2008; 80: 345-354. <https://goo.gl/s7eAuR>
45. Samelis J, Metaxopoulos J, Vlassi M, Pappa A. Stability and safety of traditional Greek salami - a microbiological ecology study. *Int J Food Microbiol*. 1988; 44: 69-82. <https://goo.gl/ZKeWiw>
46. Bilge G. The Influence of Microbiological and Biochemical Varieties of Production Temperature and Starter Culture During Sucuk Production. Graduate Thesis, Ankara University, Institute of Science, Department of Food Engineering, Ankara. 2010.
47. Casaburi A, Aristoy MC, Cavella S, Di Monaco R, Ercolini D, Toldra F, et al. Biochemical and sensory characteristics of traditional fermented sausages of Vallo di Diano (Southern Italy) as affected by the use of starter cultures. *Meat Science*. 2007; 76: 295-307. <https://goo.gl/wCmokr>
48. Essid I, Hassouna H. Effect of inoculation of selected *Staphylococcus xylosus* and *Lactobacillus plantarum* strains on biochemical, microbiological and textural characteristics of a Tunisian dry fermented sausage. *Food Control*. 2013; 32: 707-714.
49. Cicek U, Kolsarici N, Candogan K. The sensory properties of fermented turkey sausages: effects of processing methodologies and starter culture. *Journal of Food Processing and Preservation*. 2015; 39: 663-670. <https://goo.gl/Qk9HTg>
50. Lawless HT, Heymann H. Sensory evaluation of food: Principles and Practices. (2<sup>nd</sup> edn), Springer Science & Business Media, Newyork, USA. 2010. <https://goo.gl/E397hb>
51. Nazli B, Senol A. Researches on Microbiological Decomposition of Turkish Fermented Sausages. *Turk J Vet Anim Sci*. 1997; 21: 487-492. <https://goo.gl/6dV47y>
52. Bozkurt H, Bayram M. Colour and textural attributes of sucuk during ripening. *Meat Sci*. 2006; 73: 344-350. <https://goo.gl/VGLwT5>
53. Bingol EB, Ciftcioglu G, Eker FY, Yardibi H, Yesil O, et al. Effect of starter cultures combinations on lipolytic activity and ripening of dry fermented sausages. *Italian Journal of Animal Science*. 2014; 13: 776-781. <https://goo.gl/GMxqmE>
54. Candogan K, Wardlaw F B, Acton J C. Effect of starter culture on proteolytic changes during processing of fermented beef sausages. *Food Chemistry*. 2009; 116: 731-737. <https://goo.gl/zwBvTG>
55. Casaburi A, Di Monaco R, Cavella S, Toldra F, Ercolini D, Villani F. Proteolytic and lipolytic starter cultures and their effect on traditional fermented sausage ripening and sensory traits. *Food Microbiol*. 2008; 25: 335-347. <https://goo.gl/yANsoC>
56. Soyer A, Ertas AH, Uzumcuoglu U. Effect of processing conditions on the quality of naturally fermented Turkish sausages (sucuks). *Meat Science*. 2005; 69: 135-141. <https://goo.gl/jANX1L>
57. Drosinos EH, Mataragas M, Xiraphi N, Moschonas G, Gaitis F, Metaxopoulos J. Characterization of the microbial flora from a traditional Greek fermented sausage. *Meat Sci*. 2005; 69: 307-317. <https://goo.gl/t9amnV>
58. Bozkurt H, Erkmen O. Effects of starter cultures and additives on the quality of Turkish style sausage (sucuk). *Meat Sci*. 2002; 61: 149-156. <https://goo.gl/RABPgk>
59. Ozdemir H. The relationship of the dominant lactobacilli species in the microflora of Turkish fermented sausage to the organoleptic qualities of sausage. *Journal of Ankara Univ Vet Fac*. 1999; 46: 189-198.
60. Papamanoli E, Kotzekidou P, Tzanetakis N, Litopoulou-Tzanetaki E. Characterization of Micrococcaceae isolated from dry fermented sausage. *Food Microbiology*. 2002; 19: 441-449.
61. Senol A, Nazli B. Investigations on the determination of factors causing spoilage in fermented sausages. *Journal of Istanbul Univ Vet Fac*. 1996; 22: 355-370.
62. Leroy F, Verluysen J, De Vuyst L. Functional meat starter cultures of improved sausage fermentation. *Int J Food Microbiol*. 2006; 106: 270-285. <https://goo.gl/Htqaep>
63. Radulovic Z, Zivkovic D, Mirkovic N, Petrusic M, Stajic S, et al. Effect of probiotic bacteria on chemical composition and sensory quality of fermented sausages. *Procedia Food Science*. 2011; 1: 1516-1522. <https://goo.gl/A775hp>