Eurasian Journal
of Veterinary Sciences

www.eurasianjvetsci.org

RESEARCH ARTICLE

Investigation of Some Physio-Chemical and Microbiological Quality of Fresh Meat Sold Online

Tahir Yilmaz*[1], Egemen Gurdemir [1], Ayse Nizamlioglu [2], Yasin Akkemik [3], Ahmet Guner [1]

[1]Selcuk University, Veterinary Faculty, Department of Food Hygiene and Technology, Konya,Türkiye
[2]Selcuk University, Cumra Vocational School, Department of Food Processing, Konya, Türkiye
[3]Kastamonu University, Veterinary Faculty, Department of Food Hygiene and Technology, Kastamonu, Türkiye

Received: 25. 09.2022, Accepted: 17.07.2023
*tahir.yilmaz@selcuk.edu.tr

Online Sipariş Edilen Taze Etlerin Bazı Fiziko-Kimyasal ve Mikrobiyolojik Kalitelerinin İncelenmesi

Eurasian J Vet Sci, 2023, 39, 3, 106-13
DOI: 10.15312/EurasianJVetSci.2023.405

Öz

Amaç: Araştırma online satılan taze etlerin bazı kalite niteliklerini belirleyerek, online taze et satışına ve bu alanda alınması gereken önlemlere dikkat çekmek amacıyla yapıldı.

Gereç ve Yöntem: Numunelerin pH değerleri, dijital bir pH metre ile sıcaklık değerleri infrared sensörle çalışan batırma tipinde bir termometre kullanılarak tespit edildi. Numunelerin renk değerleri Chromameter renk ölçüm cihazı ile L*, a* ve b* renk değerleri ölçülerek belirlendi. Toplam canlı mikroorganizma sayısı Plate Count Agar besi yerinde, koliform bakteri sayısı Violet Red Bile Agar besi yerinde, *Staphylococcus* spp. sayısı Egg Yolk Tellurite Emulsion ilave edilmiş Baird Parker Agar besi yerinde klasik kültür teknikleri kullanılarak belirlendi.

Bulgular: Online ve müşteri olarak satın alınan parça et, kuşbaşı et ve kıymaların ortalama pH değerleri sırasıyla 5,62/5,62, 5,64/5,70 ve 5,81/5,84 olarak belirlendi. Online ve müşteri olarak satın alınan parça et, kuşbaşı et ve kıymaların ortalama sıcaklık değerleri sırasıyla 11.35/11.1°C, 11.26/11.7°C ve 12.07/12.7°C olarak belirlendi. Online ve müşteri olarak satın alınan parça et, kuşbaşı et ve kıyma numunelerinin toplam mezofilik aerobik bakteri sayısı sırasıyla 5,69/5,09, 6,34/5,68 ve 7,01/6,36 log10 kob/g olarak belirlendi. Soğuk zincir altında online olarak satın alınan ve soğuk zincir olmadan müşteri olarak satın alınan örneklerde sıcaklık değerleri ve mikrobiyolojik sonuçlar benzerlik göstermiştir.

Öneri: Elde edilen bulgular ışığında, mevzuatın yeniden düzenlenmesinde online etin sıcaklık değerleri, paketleme şekilleri ve sevkiyat koşullarının daha fazla öne çıkması gerektiği düşünülmektedir.

Anahtar kelimeler: Denetim, online et, soğuk zincir.

Abstract

Aim: The research was carried out to draw attention to online fresh meat sales and the precautions to be taken in this area by determining some quality characteristics of fresh meat sold online.

Materials and Methods: The pH values of the samples were determined using a digital pH meter and the temperature values were determined using an infrared sensor-operated immersion thermometer. The color values of the samples were determined by measuring the L*, a*, and b* color values with a Chromameter color measuring device. The total viable counts was determined in Plate Count Agar medium, coliform bacteria number in Violet Red Bile Agar medium, *Staphylococcus* spp. number in Baird Parker Agar medium supplemented with Egg Yolk Tellurite Emulsion using classical culture techniques.

Results: The mean pH values of pieced, cubed and minced meat purchased online and customers were respectively 5.62/5.62, 5.64/5.70, and 5.81/5.84. The average temperature values of pieced, cubed, and minced meat purchased online and customers were respectively 11.35/11.1°C, 11.26/11.7°C, and 12.07/12.7°C. Total viable counts of pieced, cubed, and minced meat purchased online and customers were respectively determined as 5.69/5.09, 6.34/5.68, and 7.01/6.36 log10 cfu/g. Temperature values and microbiological results determined in both meat samples purchased online with cold chain and customers without cold chain were similar.

Conclusion: In light of the results, it is thought that the temperature values, packaging forms, and shipping conditions of online meat should be more prominent in the reorganization of legislation.

Keywords: Legislation, online meat, cold chain.

CITE THIS ARTICLE: *Yilmaz et al, 2023. Investigation of Some Physio-Chemical and Microbiological Quality of Fresh Meat Sold Online Eurasian J Vet Sci, 39, 2, 106-113*

Introduction

Raw red meat can be contaminated during storage and distribution. In case of non-compliance with the storage temperature, it creates an ideal environment for the colonization of many pathogenic and saprophytic microorganisms (Liu et al 2019). Mainly saprophytic (e.g., *Pseudomonas, Acinetobacter, Aeromonas, Brochotrix thermopsphacta, Alteromonas putrafaciens, Lactobacillus spp.)* (Aidani et al 2014) and pathogenic microorganisms (e.g., *Salmonella* Enteritidis, *Salmonella* Typhimurium, *Listeria monocytogenes, Escherichia coli* O157:H7, *Staphylococcus aureus*) (Soyutemiz 2000, Aidani et al 2014) that can contaminate fresh meat create potential risks in terms of product quality and public health.

In recent years, consumers have been demanding fresh meat and meat products that are safe, high quality, delicious, and have a long shelf life. In line with consumer demands, various preservation methods are applied to preserve the quality characteristics of meat and extend its shelf life (Aymerich et al 2008). Besides these methods keeping the meat in the cold chain until it reaches the consumer is critical for meat hygiene, shelf life, and sensory properties (Ockerman and Basu 2004) and thus, cold storage is reported to be effective in reducing risks to food safety (James and James 2009) by eliminating and suppressing many pathogenic microorganisms that threaten public health.

Today, in addition to the changes in consumers' preferences and expectations, innovations in the food sector and their effects on the global market attract the attention of the scientific world. In parallel with all these developments, foodstuffs can be marketed directly to consumers within or between countries via the internet as it provides fast and easy shopping opportunities in recent years. It has been reported that online fresh food sales in China exceeded USD 20 billion in 2016 and the annual growth rate was over 70%, while laws and regulations on selling food online are relatively weak (Liu et al 2019). However, since fresh meat, which has an important place in human nutrition, undergoes various changes and deteriorations due to the activities of enzymes and contaminating microorganisms in its structure (Ertaş 1979), it must be preserved well until consumption. Liu et al (2019) analyzed the total volatile basic nitrogen, TVC, and coliform counts of 135 samples to investigate the quality of chilled pork collected from 45 online stores in China. Researchers reported that meat sold online in China poses potential hazards, temperature control, and package model are important in online meat quality to ensure meat safety. According to the Turkish Regulation on Food Hygiene (Anonymous 2011a), the vehicles and/or containers used in the transport of food should keep the transported food at suitable temperatures, enable monitoring of the determined temperatures, and the food business operator must protect and record the cold chain. According to Grunert (2006), the main issues that need to be addressed in the sale of fresh meat online, which is quite new to the consumer in terms of convenience, variety, and new experiences, are health concerns, quality, ethics, and the environment.

This study was conducted to determine some quality characteristics of fresh meat sold on the internet, which started a few years ago in Türkiye as well as all over the world, and to emphasize the need for regulation of online meat sales in food legislation.

Material and Methods

Material

In this research, pieced meat, cubed meat, and minced meat samples from four different companies that sell meat online and have market chains were ordered online. In addition, online purchase; pieced, cubed, and minced meat samples were obtained from these companies without applying the cold chain, in accordance with the routine conditions of the consumer's meat purchase. All samples were purchased at four different times. Physicochemical and microbiological analyzes were started immediately after the samples arrived at the laboratory.

Method

The pH values of the samples were determined using a digital pH meter (InoLab pH 720 model, WTW, GmbH, Germany) (Association of Official Analytical Chemist 1984). The temperature values were determined using an infrared sensor-operated penetration thermometer (testo 104 type). Color determination was carried out by measuring L*, a*, and b* color values with a Chromameter color measuring device (Chroma Meter CR-400, Konica Minolta) (Insausti et al 1999, Mancini and Hunt 2005). Total viable count (TVC) of samples in Plate Count Agar (PCA, Merck, 105463), coliform bacteria count in Violet Red Bile Agar (VRBA, Merck, 101406) (Harrigan and McCance 1976), *Staphylococcus* spp. count in Baird Parker Agar (BPA, Merck, 105406) with Egg Yolk Tellurite Emulsion (Merck, 103785) were detected after incubation at appropriate temperatures and times (Corry et al 2003, Halkman 2005, Tallent et al 2016).

Statistical analysis

Statistical analyzes of the values obtained as a result of the research were carried out by the variance analysis, the Duncan Test for the differences between the sources of variance, and the T-test to determine differences between online and customer-purchased meats using the SPSS package program (SPSS/PC version 21.00, SPSS Inc, Chicago, IL, USA) (Steel and Torrie 1981).

Results

The mean pH values of pieced, cubed, and minced meat purchased online were respectively 5.62, 5.64, and 5.81, and those purchased as customers were respectively 5.62, 5.70, and 5.84 (Figure 1A). Although the differences between the companies in terms of pH values of the meat purchased as a customer from four different companies were not significant ($p>0.05$), it was significant ($p<0.05$) in the pieced meat purchased online. According to the t-test results of the pH values of the samples obtained as online and customers, the differences in the pH values of the pieced meat and cubed meat were found to be significant ($p<0.05$).

The mean temperature values of pieced, cubed, and minced meat purchased online were respectively 11.35, 11.26, and 12.07°C, and the temperature values of those purchased as customers were respectively 11.1, ,11.7 and 12.7°C (Table 1). While the differences in the temperature values of pieced, cubed and minced meat purchased as customers from four different companies were not significant ($p>0.05$), the differences in the pieced and cubed meat purchased online were significant ($p<0.05$). The t-test results of the differences in temperature values of the samples purchased online and as customer were not significant ($p>0.05$).

Table 1. Temperature Values of Meat Purchased as Online and Customer

			Pieced meat				Cubed meat				Minced meat			
		n	Max	Min	Average(SD)	P	Max	Min	Average(SD)	P	Max	Min	Average(SD)	P
Online*	1	4	14,3	11,9	13,17±0,5^{a}		16,0	12,8	14,35±0,6^{c}		15,0	12,1	13,42±0,6	
	2	4	15,8	10,5	12,95±1,1^{a}		15,2	11,0	13,20±1,1^{bc}		16,8	9,2	13,27±1,6	
	3	4	9,7	6,1	7,92±0,7^{b}	0,00**	8,3	3,8	6,42±0,9^{a}	0,00**	11,5	9,4	10,37±0,5	0,20**
	4	4	14,1	9,4	11,37±1,0^{a}		12,8	9,1	11,07±0,9^{b}		14,8	9,4	11,22±1,2	
	T	16	15,8	6,1	11,35±0,6		16,0	3,80	11,26±0,8		16,8	9,2	12,07±0,6	
			Max	Min	Average(SD)	P	Max	Min	Average(SD)	P	Max	Min	Average(SD)	P
RCS*	1	4	17,0	9,40	12,2±1,6		14,0	8,70	11,6±1,2		18,7	12,7	14,9±1,3	
	2	4	12,90	6,80	9,72±1,2		14,9	9,00	11,5±1,3		16,1	4,10	10,3±3,2	
	3	4	16,10	6,10	10,2±2,0	0,4**	14,0	7,40	10,2±1,3	0,3**	14,2	11,0	12,9±0,6	0,4**
	4	4	13,50	11,50	10,5±2,0		15,2	11,4	13,5±0,8		15,1	10,7	12,6±0,9	
	T	16	17,0	6 ,10	11,1±0,7		15,2	7,40	11,7±0,6		18,7	4,10	12,7±0,9	
	Online	16			11,36±0,6	0,7*			11,26±0,8	0,2*			12,07±0,6	0,4*
	RCS	16			11,18±0,7				11,74±0,6				12,71±0,9	

RCS: Routine customer shopping, SD: Standart Deviation (+/-), *: t testi, **: Anova,

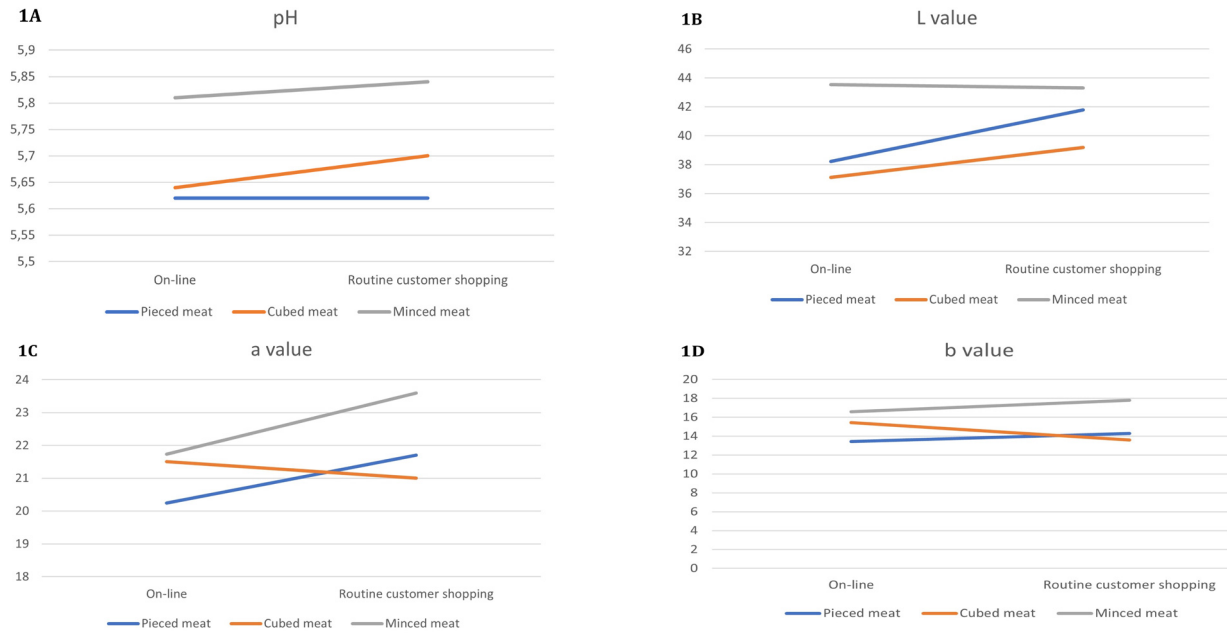

Figure 1. 1A: pH Values of Meat Purchased as Online and Customer, **1B:** L Values of Meat Purchased as Online and Customer, **1C:** a Values of Meat Purchased as Online and Customer, **1D:** b Values of Meat Purchased as Online and Customer.

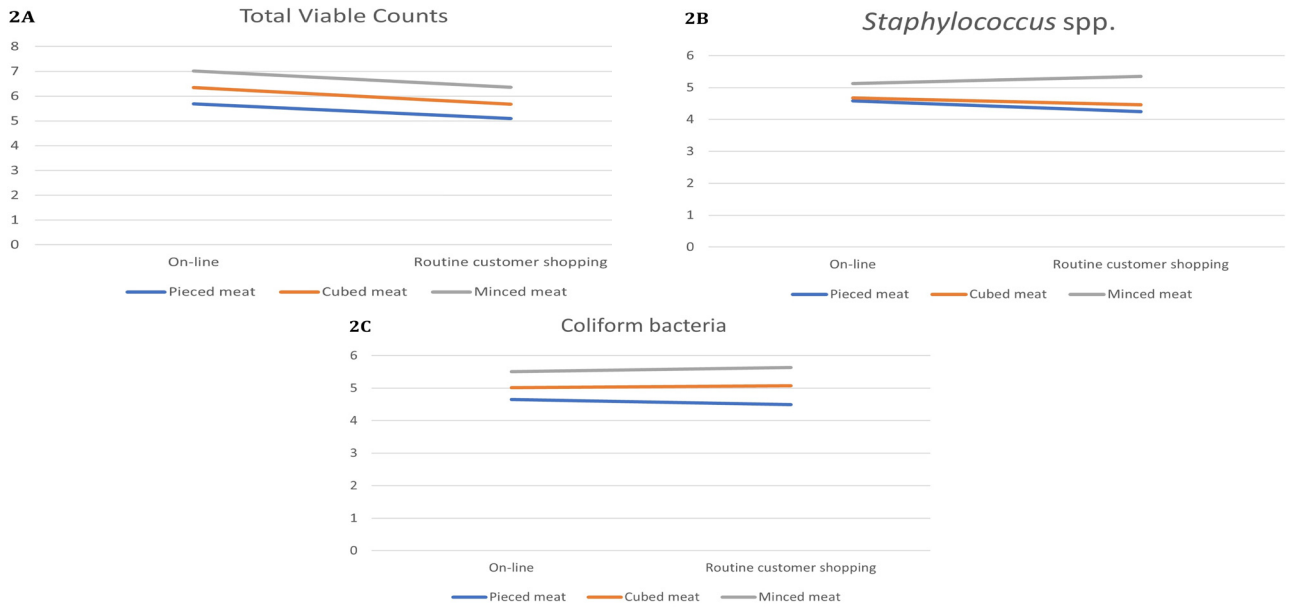

Figure 2. 2A: Total Viable Counts of Meat Purchased as Online and Customer, **2B:** Number of Staphylococcus spp. of Meat Purchased as Online and Customer, **2C:** Number of Coliform Bacteria of Meat Purchased as Online and Customer

The mean L values of pieced, cubed, and minced meats purchased online are 38.22, 37.13 and 43.55, a values are 20.25, 21.51, and 21.73, b values are 13.44, 15.44, and 16.59, respectively, and the mean L values of those purchased as a customer are 41.8, 39.2 and 43.3, a values are 21.7, 21.0 and 23.6, b values are 14.3, 13.6 and 17.8 (Figure 1B-D), respectively. Significant differences ($p<0.05$) were determined in the b values of minced meat samples purchased online and in the a values of pieced meat samples supplied as customers. The t-test results of the differences in the color values of the samples purchased online and as a customer were not found to be significant ($p>0.05$).

When the microbiological analysis findings of pieced, cubed, and minced meat purchased online were examined, the mean number of TVC were found to be 5.69, 6.34, and 7.01 log10 cfu/g respectively, number of *Staphylococcus* spp. 4.58, 4.67 and 5.12 log10 cfu/g, number of coliform bacteria 4.65, 5.01 and 5.51 log10 cfu/g. On the other hand, the mean number of TVC purchased as customers was found to be 5.09, 5.68, and 6.36 log10 cfu/g, respectively, and the number of *Staphylococcus* spp. was 4.24, 4.46, and 5.35 log10 cfu/g, and the number of coliform bacteria was 4.49, 5.07, and 5.64 log10 cfu/g (Figure 2A-C).

Significant differences in the numbers of TVC in cubed meat and *Staphylococcus* spp. in minced meat purchased online from four different companies were found ($p<0.05$). Significant differences ($p<0.05$) were determined in the number of TVC and coliform bacteria in pieced meat and *Staphylococcus* spp. in cubed meat purchased as a customers. According to the t-test results of the differences of meat samples purchased online and as a customer, *Staphylococcus* spp. in cubed meat and TVC in minced meat were found to be significant ($p>0.05$).

Discussion

Considering that cold chain management is important in terms of maintaining quality and safety in delivering fresh meat to the consumer due to its short shelf life, it was mainly aimed in this study to carry out to reveal the quality of pieced, cubed, and minced meat purchased online and to compare the quality of these piece of online meat to the same meat pieces obtained in accordance with the routine conditions of the consumer's meat purchase.

pH value is an important parameter that plays a role in the shelf life of meats. The high pH value of the meat is critical in the development and predominance of lactic acid bacteria, which play an important role in the deterioration of meat (Babji et al 2000). In this study, pH values of the meat samples supplied as online/customer were respectively determined as 5.62/5.62, 5.64/5.70 and 5.81/5.84, therefore the pH values were found to be appropriate. Similar to the findings of this study, Huidobro et al (2003) reported that the pH values of the meat decreased to 5.5 in the first 24 hours after slaughter, and there was no change in pH value during the next 5 days of cold storage. Unlike these research findings, Gök (2001) determined the pH value as 6.07 in minced meat measured before cold storage. In our study, the differences in the pH values of pieced meat purchased online from four different markets were found significant ($P<0.05$). Thus, significant differences between companies show that companies do not have certain standards in online sales procedures. On the other hand, considering the

statistical differences according to the results of the t-test in pH values of pieced meat and cubed meat procured online and as a customer, it has been concluded that if standards are established in online meat sales and controlled within the framework of the legislation, this will have significant advantages over the meats purchased as a customer.

Temperature seems to be the most influential factor in microbial growth (Liu et al 2019) and meat spoilage (Nychas et al 2008). Although some pathogenic or saprophytic microorganisms can grow at 0ºC or lower temperatures, risks to food safety can be significantly reduced by keeping fresh meat below 5ºC (James and James 2009). Cold storage of meat during the sale and transportation in the markets where it is delivered to the end consumer is critical in terms of quality and reliability (Nychas et al 2008). In the research, the average temperature values of pieced, cubed and minced meat purchased online/as customers were respectively determined as 11.35/11.1ºC, 11.26/11.7ºC, and 12.7/12.7ºC. Considering that the meat supplied online had been brought in the cold chain in transport containers, it was concluded that the temperature values detected in meat purchased online were high. Furthermore, the significant differences between companies in the temperature values of the cubed meat supplied online show that the companies do not have certain standards in online sales. However, the temperature values during the delivery of the meat are critical for the freshness, reliability, and overall quality of the meat. In this context, although it is possible to monitor and control the conditions affecting the whole chain with different methods, the complete implementation of the cold chain is still an important necessity for manufacturers, distributors, retailers, and consumers (Oliva and Revetria 2008, Nastasijević et al 2017).

The color of red meat is the first quality characteristic that the consumer sees as an indicator of freshness and health (Berruga et al 2005, Troy and Kerry 2010). Color can be adversely affected at all stages of the production chain including animal breed, diet, age, and slaughtering/marketing process (e.g., pre-slaughter treatments, stunning and bleeding, cooling variables, packaging, distribution, and marketing) (Insausti et al 1999). The increase in temperature during the cold storage and the retail sale of fresh meat accelerates the formation of metmyoglobin, causing a decrease in color stability and accelerating the formation of brown color (Rosenvold and Wiklund 2011). Similar to the findings obtained in the current research, Tolon et. al. (2000) determined the L value as 42.29 and the b value as 11.51 in fresh meat taken from the Musculus longissimus dorsi. Bozkurt et. al. (2009) determined the L value as 51.00, a value as 15.26, and b value as 5.88 of the Longissimus dorsi muscle. Alp (2008) determined the L value as 42.30, a value as 26.76, and b value as 9.28 of minced meat. In the research, significant differences ($P<0.05$) were determined in the b values of minced meat purchased online and in the a values of pieced meat supplied as customers. The fact that the significant differences between the companies in the b values of the minced meat supplied online, as in the same pH and temperature values, shows that the companies do not have certain standards in online sales procedures.

As a result of contamination by saprophytic bacteria in fresh meat, negative changes occur in sensory properties (e.g., color, flavor) (Aidani et al 2014). The most important factor in the control of meat spoilage is to protect from microbial contamination and to control the number of microorganisms that affect the safety and color of meat (Limbo et al 2010). A high TVC number can be considered as an indicator of low quality and/or reduced shelf life of the food (Aydemir Atasever and Atasever 2015). Furthermore, it has been found that the storage temperature during cooling and cold storage is associated with microbial growth of lactic acid bacteria, *Enterobacteriaceae* spp, *Clostridium perfingens*, and *Bacillus thermosphacta*, etc. (Liu et al 2019). According to the Turkish Food Codex Regulation on Microbiological Criteria (Anonymous 2011b), the number of aerobic colonies in minced meat is accepted as 5x106 cfu/cm2 in two of the five samples and 5x105 cfu/cm2 in three of them. The TVC count of meat is related to processing, storage conditions, and cooling methods (Liu et al 2019), and the initial TVC count is reported as 4 log10 cfu/g (Limbo et al 2010). In the study, the number of TVC in pieced, cubed, and minced meat purchased online/customer was respectively determined as 5.69/5.09, 6.34/5.68 ve 7.01/6.36 log10 cfu/g. Similar to the findings of this study, Aydemir Atasever and Atasever (2015) reported average TVC count as 7.33 log10 cfu/g in a total of 100 minced meat samples. Djordjević et al (2019) determined the TVC number of minced meat as 4.59 log10 cfu/g. Liu et. al. (2019) determined the number of TVC in the range of 3.84-6.86 log10 cfu/g. Unlike these research findings, Öztürk (2007) determined the TVC number of meat products between 3.49-4.18 log10 cfu/g.

One of the bacteria genus having foodborne pathogen strains frequently encountered in meat and meat products is *Staphylococcus* spp. (Erol 2007). *S. aureus* in these strains is the most important pathogenic strain associated with food poisoning. It is found mainly in the human nasopharynx and animal skin. The presence of *Staphylococcus* spp. in food indicates direct contamination of food by personnel (Gundogan et al 2005). In this research, the number of Staphylococcus spp. in pieced, cubed, and minced meat purchased online/as a customer were respectively determined as 4.58/4.24, 4.67/4.46 and 5.12/5.35 log10 cfu/g. Aydemir Atasever and Atasever (2015) determined the number of *S. aureus* at a maximum level of 4.51 $\log_{10}$ cfu/g and an average of 1.76 log cfu/g. The contamination ratio of *S. aureus* in fresh meat was reported by Gundogan et al (2005), as 60% of 90 beef, by Güven et al (1997) as

53.3% of 80 minced meat and by Sırıken (2004) as 21.4% of 70 minced meat. Öztürk (2007) reported the coagulase positive *Staphylococcus* number of the meat products as 3.42 log10 cfu/g. The number of *Staphylococcus* spp. in raw meat products was determined as minimum 2.0 log10 cfu/g (Selçuk ve Ağaoğlu 2019). It is believed that the low level of the agent detection in the studies given above may be due to the high TVC because *S. aureus* is a weak competitive feature and cannot grow well in cases where its initial number is not high in food. Its growth is easily suppressed by other microorganisms in mixed cultures (Erol 2007).

The number of coliform bacteria is another important indicator of meat quality. Some countries still use *Enterobacteriaceae* or fecal coliform as indicator, the others such as China, Norway, Israel, most of the EU countries use E. coli index to determine/predict coliform numbers in food (Liu et al 2019). In the research, the number of coliform bacteria in pieced, cubed and minced meat purchased online/as customer was respectively determined as 4.65/4.49, 5.01/4.46 and 5.51/5.35 log10 cfu/g. On the other hand, coliform bacteria number of minced meat samples was determined by Gök (2001) and Öztürk (2007), respectively as 2.87 log10 cfu/g. and 4.51 log10 cfu/g. Başkaya et. al. (2004) and Yapar (2006) found the coliform bacteria number of the minced meat as 1x104 log10 cfu/g and 21-43 EMS/g.

In the research, significant differences were found ($P<0.05$) in the number of TVC of the cubed meat and *Staphylococcus* spp. of minced meat purchased online and in the number of TVC and coliform bacteria of pieced meat and in the number of *Staphylococcus* spp. of cubed meat obtained as customers. These differences between companies show that companies do not have certain standards for online sales procedures. According to the t-test results of the samples obtained online and as customer, differences in the number of *Staphylococcus* spp. of cubed meat and TVC of minced meat samples were found significant ($P<0.05$). Considering the statistical differences in the samples purchased as online and customers, it has been concluded that if standards are established in online meat sales and controlled within the framework of the legislation, it will have significant advantages over meat purchased as a customer.

Conclusion

Due to the rapid changes in consumer's demand and the trends in food consumption of the future consumer, food manufacturers need innovation and studies on this subject as a way of survival in trade (Grunert 2006). Meat sales over the internet, which has emerged in recent years in parallel with the continuous improvement and innovation, has created a fast and easy shopping opportunity for consumers. This research was conducted to reveal the quality of the meat sold over the internet and to share the subject with all concerned, it was determined that the pH values of the samples were appropriate in the meat samples supplied online and as customers, and the temperature values were quite high. Statistical differences between companies in terms of pH, temperature, color and microorganism numbers in meats purchased online emphasize the necessity of companies' online sales procedures to have certain standards. When the samples are compared as online and customer, considering the statistical differences in pH values and microbiological findings according to the t-test results, it has been concluded that if standards are set in online meat sales and controlled within the framework of the legislation, it will have significant advantages over the meat purchased as a customer.

In the light of these findings, it is believed that online meat sales should be more prominent in the legislation, as potential food safety risk and poor quality may occur in meats. If the necessary care and control are not performed in online sales, which provide quick and easy shopping for the consumer, online meat will be a major public health problem. In the legislation, it is important to determine the values of the end point temperature when it reaches the consumer, and to define the packaging forms and shipping conditions.

Acknowledgements

This study was presented as a oral presentation at the 9th Veterinary Food Hygiene and Technology Congress and was published as a summary text in the congress book (4-7th November 2021, Kayseri, Turkey)

Conflict of Interest

The authors did not report any conflict of interest or financial support.

Funding

During this study, any pharmaceutical company which has a direct connection with the research subject, a company that provides and / or manufactures medical instruments, equipment and materials or any commercial company may have a negative impact on the decision to be made during the evaluation process of the study or no moral support.

References

Aidani E, Ahamohammadi B, Akbarian M, Morshedi A, et al., 2014. Effect of chilling, freezing and thawing on meat quality: a review. Int J Biol Sci, 5(4), 159-169.

Alp E, 2008. Effects of water extract of Urtica dioica L. and

modified atmosphere packaging on the shelf life of ground beef. Meat Sci, 86(2), 468-73.

Association of Official Agricultural Chemists & Horwitz W, 1975. Official methods of analysis (222). Washington, DC: Association of Official Analytical Chemists.

Aydemir Atasever M and Atasever M, 2015. Isolation and identification of some pathogens from minced meat samples. J Ist Faculty Med, 41(1), 60-68.

Aymerich T, Picouet PA, Monfort JM, 2008. Decontamination technologies for meat products. Meat Sci, 78(1-2), 114-129.

Babji Y, Murthyb TRK., Anjaneyulu ASR, 2000. Microbial and sensory quality changes in refrigerated minced goat meat stored under vacuum and in air. Small Rumin Res, 36, 75-84.

Başkaya R, Karaca T, Sevinçi İ, Çakmak Ö, et al., 2004. The histological, microbiyological and serological quality of ground beef marketed in Istanbul. Van Vet J, 15(1-2), 41-46.

Berruga MI, Vergara H, Gallego L, 2005. Influence of packaging conditions on microbial and lipid oxidation in lamb meat. Small Rumin Res, 57, 257–264.

Bozkurt Y, Özkaya S, Kılıç B, 2009. Comparison of two different methods to predict meat quality and prediction possibility using digital image analysis. Kafkas Vet J, 15(4), 485-489.

Corry JEL, Curtis GDW, Baird CRM, 2003. Culture media for food microbiology, Elsevier Sci, Amsterdam, pp; 400-403.

Djordjević J, Bošković M, Lazić IB, Djordjević V, et al., 2019. Spoilage-related bacteria of pork and beef minced meat under vacuum and modified atmosphere. Rom Biotechnol Lett, 24(4), 658-668.

Erol İ, 2007. Gıda Hijyeni ve Mikrobiyolojisi. Pozitif Matbaacılık Ltd Şti, Ankara.

Ertaş AH, 1979. Ette Bozulmaya neden olan mikroorganizmalar. J Food Sci, 4(6), 187-191.

Gök V, 2001. Sığır kıymalarının raf ömrünün uzatılması üzerine vakum paketleme ve bazı katkı maddelerinin etkilerinin araştırılması (Unpublished master's thesis), Celal Bayar Universty, Manisa, Turkey.

Grunert KG, 2006. Future trends and consumer lifestyles with regard to meat consumption. Meat Sci, 74(1), 149-160.

Gundogan N, Citak S, Yucel N, Devren A, 2005. A note on the incidence and antibiotic resistance of *Staphylococcus aureus* isolated from meat and chicken samples. Meat Sci, 69(4), 807-810.

Güven A, Gülmez M, Kamber U, 1997. Kars ilinde tüketime sunulan kıymalarda bazı patojen mikroorganizmaların araştırılması ve kıymaların mikrobiyolojik kalitesinin belirlenmesi. Kafkas Univ Vet Fak, 3, 57-65.

Halkman K, 2005. Merck Mikrobiyoloji El Kitabı, Başak Matbaacılık, Ankara, Türkiye.

Harrigan WF, McCance ME, 1976. Laboratory methods in food and dairy microbiology. Academic Press, Inc (London) Ltd.

Huidobro FR, Miguel, Onega E, Bla´zquez B, 2003. Changes in meat quality characteristics of bovine meat during the first 6 days post mortem. Meat Sci, 65, 1439–1446.

Insausti K, Beriain MJ, Purroy A, Alberti P, et al., 1999. Colour stability of beef from different Spanish native cattle breeds stored under vacuum and modified atmosphere. Meat Sci, 53(4), 241-249.

James SJ and James C, 2009. Improving the sensory and nutritional quality of fresh meat. In: Chilling and freezing of meat and its effect on meat quality, Ed: Kerry JP, Ledward D, Woodhead Publishing Ltd, pp; 539-560.

Limbo S, Torri L, Sinelli N, Franzetti L, et al., 2010. Evaluation and predictive modeling of shelf life of minced beef stored in high-oxygen modified atmosphere packaging at different temperatures. Meat Sci, 84, 129–136.

Liu CX, Xiao YP, Hu DW, Liu JX, et al., 2019. The safety evaluation of chilled pork from online platform in China. Food Control, 96, 244-250.

Mancini RR and Hunt MC, 2005. Current Research in Meat Color. Meat Science, 71, 100-121.

Nastasijević I, Lakićević BA, Petrović Z, 2017. Cold chain management in meat storage, distribution and retail: A review. IOP Conf Ser: Earth Environ Sci, 85(1), 012-022.

Nychas GJE, Skandamis PN, Tassou CC, Koutsoumanis KP, 2008. Meat spoilage during distribution. Meat Sci, 78(1-2), 77–89.

Ockerman HW, Basu L, 2004. Carcass chilling and boning, In: Encyclopedia of Meat Sci, Ed: Jensen WK, Devine C, Dikeman M, Academic Press, pp; 144–149.

Oliva F and Revetria R, 2008. A system dynamic model to support cold chain management in food supply chain., paper presented at the: 12th WSEAS International Conference on Systems, Heraklion, Greece, July 22-24,12,361-365.

Öztürk U, 2007. Antalya'da Tüketime Sunulan Kıyma ve Kırmızı Et Preparatlarının Mikrobiyolojik Kalitesi, (Unpublished doctoral thesis), Selcuk Universty, Konya, Turkey.

Turkish Food Hygiene Regulation. (2011a, 17 December). Anonymous (Sayı: 28145). Access address: https://www.resmigazete.gov.tr/eskiler/2011/12/20111217-5.htm.

Turkish Food Codex Regulation on Microbiological Criteria. (2011b, 29 December) Anonymous (Sayı: 28157). Access address https://www.resmigazete.gov.tr/eskiler/2011/12/20111229M3-6.htm.

Rosenvold K and Wiklund E, 2011. Retail colour display life of chilled lamb as affected by processing conditions and storage temperature. Meat Sci, 88(3), 354-360.

Selçuk Ü and Ağaoğlu S, 2019. The Microbiological Quality of Tantuni. Turkish J Vet Res, 3(1), 37-44.

Sırıken B, 2004. The microbiological quality of ground beef in Aydin and Afyon Provinces, Turkey. Revue Méd Vét, 155(12), 632-6.

Soyutemiz E, 2000. Et ve Et Ürünlerinde Mikrobiyal Bozulmalar. J Food Sci, 3, 52-57.

Steel RGD and Torrie JH, 1981. Analysis of variance in factorial experiments. Principles and procedure of

statistics, 336-375.

Tallent S, Hait J, Bennett RW, Lancette GA, 2016. *Staphylococcus aureus*. Bacteriological Analytical Manual. Maryland, MD: US Food and Drug Administration.

Tolon B, Önenç A, Kaya A, Altan Ö, 2000. Balla Muamelenin Sığır Etinde Bazı Kalite Özellikleri Üzerine Etkileri. Hayvansal Üretim, 41(1), 38-47.

Troy DJ and Kerry JP, 2010. Consumer Perception and the Role of Science in The Meat Industry. Meat Sci, 86, 214–226.

Yapar F, 2006. Parça et ve kıymalarda erik ekşisi, nar ekşisi ve limon tuzunun antibakteriyal etkisi (Unpublished master's thesis), Cukurova universty, Adana, Turkey.

Author Contributions

Motivation/Concept: AG, YA, AN; Design: YA, AG; Control/ Supervision: AG; Data Collection and/or Processing: TY, EG, AN; Analysis and / or Interpretation: EG, AN, TY.

Ethical Approval

Ethics committee approval was given by SUVDAMEK with 2022/12 meeting number and 2022/19 decision number.