Effect of yoghurt or yoghurt serum on microbial quality of cig kofte

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Abstract Cig kofte, raw meatball is a traditionally produced meat product in Turkey and some other Middle East countries. It is prepared from mixtures of finely minced raw beef, bulgur, onions, various spices and tap water. Cig kofte is an uncooked product and popularly consumed with lettuce and lemon juice. In this study, yoghurt or yoghurt serum (YS) were added to the mixtures of cig kofte instead of tap water to reduce microbial risks of the raw meatball. Additionally, the effects of yoghurt and YS on some physicochemical characteristics of cig kofte were investigated. Cig kofte is generally consumed within a few hours after the preparation because of its raw nature. Also, it is generally sold under unhygienic conditions in restaurants and restaurant-like places. For this purpose, reducing of the microbial load of cig kofte is important. In the results, *Escherichia coli* and *Listeria monocytogenes* were not detected in any samples. While lactic acid bacteria count increased by addition of yoghurt and YS, the number of other microorganisms except for total aerobic mesophilic bacteria (TAMB) were decreased. The a_w values and % moisture contents of the samples were varied between 0.88–0.94 and 46.25–49.72, respectively. The pH values of

the samples were slightly changed during the storage of 24 h while no changes detected in the control samples during the storage. In conclusion, it can be suggested that using the yoghurt or YS instead of tap water in the preparation of cig kofte might ensure the microbial safety, increase the nutritional value and its flavour or aroma.

Keywords Cig kofte · Yoghurt · Yoghurt serum · Microbiological load

Introduction

Cig kofte (raw meatball) is a traditional food product consumed as appetizer usually in Turkey and other Middle East countries. Cig kofte contains lean meat, bulgur, hot or soft red pepper, black pepper, onion, cumin, pepper paste and salt. In addition to these ingredients, various species and condiments such as cinnamon, allspice, vegetable oil, mint and garlic are added based on the consumer preference (Goktan and Tuncel 1988; Erol et al. 1993; Ocal 1997; Genccelep et al. 2001; Yildirim et al. 2005). Cig kofte is prepared by hand kneading of these ingredients with some water. Additionally, cig kofte is an uncooked meat product; therefore it may cause serious health risk due to its microbial loads including some pathogenic microorganisms (Uzunlu and Yildirim 2003). Kilic (2009) reported that high counts of total aerobic mesophilic bacteria (TAMB), *Staphylococcus aureus*, *Enterobacteriaceae*, coliform, *Escherichia coli*, *Enterococcus* spp., *Pseudomonas* spp. and *Bacillus cereus* were detected in cig kofte samples. However, consumers of the cig kofte think that using of the spices e.g. red pepper, onion and garlic may eliminate pathogens or harmful microbial load of the raw meatballs (Yildirim et al. 2005). But, many studies showed that cig kofte is not suitable for the consumption of people

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because of possibility of foodborne pathogens or microbiological safety (Uzunlu et al. 2002; Kuplulu et al. 2003; Elmali and Yaman 2005). For this reason, recent studies have been planned to decrease microbiological load of cig kofte and inactivate the pathogens (Sagun et al. 2003; Durmaz et al. 2007; Calicioglu and Dikici 2008; Colak et al. 2008; Gumus et al. 2008).

Yoghurt is a fermented dairy product obtained by fermentation of milk using *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*. It is a highly nutritious protein-rich product (Kumar and Mishra 2004) and consumers prefer yoghurt because of its flavour and aroma compounds including lactic acid and acetaldehyde. Additionally, yoghurt has some antagonistic, antimutagenic, anticarcinogenic and therapeutic activities (Kumar and Mishra 2004). Moreover, the low pH, lactic acid, the bacteria and acetaldehyde contents of yoghurt provide high antimicrobial effects on the growth of many spoilage and pathogenic microorganisms (Gilliland 1991; Akkaya et al. 2009).

Cig kofte is prepared from mixtures of raw materials including minced beef, bulgur and different spices. It is traditionally consumed with lettuce and lemon juice in the ceremony within a few hours of preparation. Also, it is generally sold under unhygienic conditions in restaurants and restaurant-like places. Therefore, microbial safety of cig kofte can be obtained with lemon juice and various spices besides to the application of hygiene rules. Because, the cig kofte has several pathogenic microbial and parasitic risks originating from raw materials. Therefore, aims of the study were first to reduce microbial risks in the cig kofte adding with yoghurt or YS, and second to give better flavour and aroma properties to the cig kofte with the same additives.

Materials and methods

Materials

For the preparation of the cig kofte samples, bulgur, beef, all the spices, salt and onion were purchased from a local market in Kayseri, Turkey.

Preparation of cig kofte (raw meatball)

The 125 g of bulgur, 18.5 g of pepper paste, 100 g of lean beef, 3.5 g of salt, 7 g of isot (Turkish hot red pepper), 1 g of hot red chili pepper powder, 3.5 g of sweet red pepper powder and 1 g of hot red pepper powder, 0.75 g of cumin, 1 g of black pepper powder and 12.5 g of onion were mixed thoroughly. Then the mix were divided into 3 equal parts; 1) the control sample, 2) the sample with yoghurt and 3) the sample with yoghurt serum (YS), and the each kofte dough were prepared from the mixture of the above ingredients

with adding an equal amount (80 g each) of tap water, yoghurt or YS, respectively. Yoghurt and YS amounts were previously selected according to the most liked scores as a result of sensory analysis and the most suitable cohesion for the cig kofte. All the three different samples were separately kneaded by hand throughout 1 h. Then the prepared cig kofte samples were shaped and stored for 24 h at refrigerator temperature (4 °C). The microbiological analyses were conducted at 1st, 3rd, 6th, 10th, 18th and 24th hours of the storage. Each measurement was replicated three times with two repetitions.

Physicochemical analyses

Moisture contents of the cig kofte, yoghurt and yoghurt serum were determined according to the procedure of AOAC (2000). The pH values, the water activities (a_w) and colour of the samples were determined by pH meter (WTW-Inolab, Weilheim, Germany), a_w meter (Aqua Lab, USA) and colourimeter (Lovibond Tintometer, England) respectively. All of the measurements in this part were replicated three times with two repetitions.

Microbiological analysis

The cig kofte samples (10 g) were homogenized with 90 mL of a sterile ringer solution at room temperature, and their decimal dilutions were prepared in a 9 mL serial sterile ringer solutions. Total aerobic mesophilic bacteria (TAMB) were enumerated on plate count agar (Merck) following the pour-plate method and incubated at 30 °C for 72 h. Total coliforms and *Escherichia coli* were determined on Violet Red Bile (VRB) and Eosin Metilen Blue (EMB Agars, and incubated at 30 and 37 °C for 24–48 h, respectively. *Staphylococcus aureus* was enumerated by plating on Baird Parker egg yolk telluride medium following the surface plate method, and incubated at 37 °C for 48 h. Bright black colonies were recorded as *S. aureus*. *Listeria* spp. was grown on Oxford Agar containing *Listeria* selective supplement incubated at 37 °C for 24–48 h. Then black colonies on the agar were recorded as *Listeria* spp. Lactic acid bacteria (LAB) were enumerated on MRS agar using the pour-plate method with incubation at 37 °C for 3 d. Cycloheximide (10 ppm) was added to MRS agar to inhibit mould and yeasts. Yeasts were determined on yeast extract glucose chloramphenicol agar (YGC Agar) with incubation at 25 °C for 3–5 days. All microbial counts are presented as an average of the logarithm ($\log_{10}$) of colony forming unit (cfu)/g in the samples. All microbial media were obtained from Merck (Darmstadt, Germany). Microbiological analyses were replicated three times with two repetitions.

Statistical analysis

The statistical analyses were applied using analyses of variance and Duncan multiple range tests by the SPSS 17.0.1 programme (Ural and Kilic 2006). In this study, two repetitions were carried out and the measurements were replicated three times in each repetition.

Results and discussion

Moisture content, a_w and color (L , a and b) values of the cig kofte samples were shown in Table 1. According to the table, average moisture contents of the cig kofte samples prepared with tap water, yoghurt and YS were 49.72%, 46.25% and 48.73%, respectively. The moisture contents were affected from the raw materials and ingredients used in the cig kofte preparation. For example, yoghurt and YS added to the cig kofte had 12% and 6% dry mater, respectively. Thus, yoghurt and YS affected the moisture content of the cig kofte, therefore, the moisture contents of the samples prepared with tap water, yoghurt and YS were different from each other ($P<0.05$). Water activity (a_w) values of the control, yoghurt and YS added samples were found as 0.94, 0.88 and 0.91, respectively (Table 1). Table 1 shows that the addition of yoghurt or YS significantly affected the a_w values of the cig kofte samples ($P<0.05$). The sample prepared with yoghurt had lowest a_w value which might prevent the microbial growth. Additionally, as can be seen Table 1, L and b values of the samples prepared with yoghurt or YS were statistically different from the control samples ($P<0.05$). These differences, as would be expected, were resulted from variation of the colour values of yoghurt, YS and/or tap water added to cig kofte. However, the differences between a values of the control and other samples were statistically insignificant ($P>0.05$). The colour values of the samples containing yoghurt and YS were not significantly different ($P>0.05$).

Table 2 shows the changes in pH values of the cig kofte samples at first, 3rd, 6th, 18th and 24th hours. It is clearly seen from the this table that pH values of the control sample prepared with tap water were slightly higher than that of the other formulations throughout the storage period. However, there were not statistically significant differences between the samples prepared with yoghurt and the YS ($P>0.05$). The pH values of the control samples did not change during the storage ($P>0.05$). In this study, pH and moisture contents of the samples were lower than those of the Durmaz et al. (2007) reported. This difference might be originated from the differences among the formulations used.

Microbiological characteristics of the cig kofte samples were also given in Table 2. Microbiological loads of the cig kofte samples depend on the microflora of raw materials used e.g. the lean minced meat, spices, onion, pepper paste, salt and bulgur (Erol et al. 1993; Sagun et al. 1997a, b; Genccelep et al. 2001; Sancak and Isleyici 2006). While the sample prepared with yoghurt had the lowest TAMB count, the control cig kofte sample had the highest TAMB (Table 2). The addition of yoghurt or YS caused to decrease in TAMB counts. The differences among the TAMB counts of the samples during the storage period were also statistically significant ($P<0.05$) (Table 2). In another study, Aydin et al. (2007) reported that 5% and 10% of garlic added to formulation decreased the TAMB counts of the cig kofte. Therefore, some bioactive components of the additives e.g. yoghurt, garlic and spices incorporated into cig kofte can inhibit the growth of some microorganisms.

In the study, coliform bacteria counts in the control sample was initially determined as 3.00 log cfu/g, but it continuously decreased during the storage period, and at the end of the storage, it was 2.33 log cfu/g. Additionally, coliform bacteria were not detected in the samples prepared with yoghurt during the storage while the bacteria in the sample with YS were fully inhibited at the first hour. According to these results, yoghurt or YS addition to the cig kofte caused to inhibit coliform bacteria count (Table 2). Coliform bacteria may always be found in cig kofte as

Table 1 Some physicochemical properties of raw meat balls having different formulations

Samples	Color			a_w	Moisture (%)
	L	a	b		
Control with tap water	42.0 ^a ±0.46	15.6 ^a ±0.31	27.4 ^b ±0.56	0.94 ^a ±0.01	49.7 ^a ±0.46
Cig kofte with yoghurt	40.2 ^b ±0.56	16.3 ^a ±0.52	29.9 ^a ±1.20	0.88 ^c ±0.01	46.3 ^c ±0.42
Cig kofte with YS	40.0 ^b ±0.93	16.3 ^a ±0.50	29.6 ^a ±1.19	0.91 ^b ±0.01	48.7 ^b ±0.12

Superscript letters indicate the statistical difference in the column at 5% significant level

(YS: Yoghurt serum)

Values are mean ± SD ($n=3$)

Table 2 Changes in pH and microbial characteristics of the cig kofte samples during storage (4 °C)

pH values and Microbiological properties (log cfu/g)	Storage time (h)	Samples		
		Control	Cig kofte with yoghurt	Cig kofte with YS
pH	0	5.5 ^{Aa} ±0.01	5.0 ^{Bb} ±0.03	5.0 ^{Bb} ±0.02
	3	5.5 ^{Aa} ±0.02	5.1 ^{Ba} ±0.04	5.1 ^{Ba} ±0.01
	6	5.5 ^{Aa} ±0.02	5.1 ^{Ba} ±0.03	5.1 ^{Ba} ±0.02
	18	5.5 ^{Aa} ±0.01	5.1 ^{Ba} ±0.06	5.1 ^{Ba} ±0.03
	24	5.5 ^{Aa} ±0.03	5.1 ^{Ba} ±0.02	5.1 ^{Ba} ±0.03
TAMB	0	4.9 ^{Aa} ±0.02	4.7 ^{Ca} ±0.01	4.8 ^{Ba} ±0.01
	3	4.9 ^{Aa} ±0.03	4.4 ^{Cb} ±0.06	4.6 ^{Bb} ±0.03
	6	4.5 ^{Ac} ±0.03	4.4 ^{Bb} ±0.04	4.4 ^{Bd} ±0.03
	18	4.5 ^{Abc} ±0.03	4.4 ^{Bb} ±0.04	4.5 ^{ABc} ±0.04
	24	4.6 ^{Ab} ±0.01	4.5 ^{Cb} ±0.04	4.6 ^{Bb} ±0.03
LAB	0	4.2 ^{Ca} ±0.01	4.2 ^{Aa} ±0.01	4.2 ^{Ba} ±0.01
	3	4.2 ^{Ca} ±0.00	4.2 ^{Aa} ±0.01	4.2 ^{Ba} ±0.01
	6	4.2 ^{Aa} ±0.02	4.2 ^{Aa} ±0.01	4.1 ^{Bb} ±0.02
	18	4.2 ^{Aa} ±0.02	4.2 ^{Aa} ±0.01	4.0 ^{Bc} ±0.04
	24	3.4 ^{Cb} ±0.03	3.7 ^{Ab} ±0.01	3.5 ^{Bd} ±0.01
Yeasts	0	3.3 ^{Aa} ±0.03	2.4 ^{Ba} ±0.01	2.1 ^{Ca} ±0.09
	3	3.2 ^{Ab} ±0.09	<1 ^{Bb}	<1 ^{Bb}
	6	2.9 ^{Ac} ±0.03	<1 ^{Bb}	<1 ^{Bb}
	18	<1 ^{Ad}	<1 ^{Ab}	<1 ^{Ab}
	24	<1 ^{Ad}	<1 ^{Ab}	<1 ^{Ab}
Coliform	0	3.0 ^{Aa} ±0.01	<1 ^{Ca}	2.7 ^{Ba} ±0.02
	3	2.9 ^{Ab} ±0.02	<1 ^{Ba}	<1 ^{Bb}
	6	2.7 ^{Ac} ±0.03	<1 ^{Ba}	<1 ^{Bb}
	18	2.6 ^{Ad} ±0.01	<1 ^{Ba}	<1 ^{Bb}
	24	2.3 ^{Ac} ±0.06	<1 ^{Ba}	<1 ^{Bb}
<i>S. aureus</i>	0	3.3 ^{Aa} ±0.03	2.4 ^{Ba} ±0.01	2.1 ^{Ca} ±0.02
	3	3.2 ^{Aa} ±0.09	<1 ^{Bb}	<1 ^{Bb}
	6	2.9 ^{Ab} ±0.03	<1 ^{Bb}	<1 ^{Bb}
	18	<1 ^{Ac}	<1 ^{Ab}	<1 ^{Ab}
	24	<1 ^{Ac}	<1 ^{Ab}	<1 ^{Ab}

TAMB: Total aerobic mesophilic bacteria; LAB: Lactic acid bacteria. Control: Normal cig kofte, YS: Yoghurt serum

<1: No detectable

Uppercase letters indicate the statistical difference in the rows at 5% significant level

Lowercase letters indicate the statistical difference in the columns for each parameter at 5% significant level

Values are mean ± SD (n=3)

contaminants. For example, Arslan et al. (1992) determined that 55.5% of the 45 cig kofte samples had coliform bacteria.

Staphylococcus aureus and yeast were not detected in control group after sixth hour while at the first hour in yoghurt or YS containing samples (Table 2). While control sample had initially around $\leq 10^3$ kob/g of *S. aureus* and yeast counts, the samples containing yoghurt or YS had $\leq 10^2$ kob/g of *S. aureus* and yeast. It would be speculated that Yoghurt or YS addition to the cig kofte may have been inhibit the growth of *S. aureus* and yeast. Similarly, Aydin et al. (2007) reported that 5% and 10% of garlic added to cig kofte decreased yeast and mould counts. Additionally, *S. aureus* may be found in cig kofte as a contaminant depending on

personal hygiene. Thus, Arslan et al. (1992) reported that 6.6% of 45 cig kofte samples analyzed contained coagulase positive *S. aureus* (10^5 – 10^6 cfu/g). *Listeria* spp. and *E. coli* could not be detected in all the cig kofte samples produced. Kotz et al. (1990) and Yesillik et al. (2011) reported that yoghurt inhibited the growth of *E. coli*, *Pseudomonas aeruginosa*, *Salmonella typhimurium* and *S. aureus*. Yogurt bacteria including *Lb. delbrueckii* subsp. *bulgaricus* and *Str. thermophilus* produce lactic acid and other metabolites (e.g. H_2O_2 and bacteriocins) which have an antimicrobial effect on spoilage on pathogenic microorganisms in foods (Turantas and Kemahlioglu 2012). The antibacterial effect of yoghurt might be resulted from lactic acid and the other metabolites. The previous studies support the results of our study.

Conclusion

The results of the study indicate that yoghurt and yoghurt serum used in the cig kofte preparation might have a potential as antimicrobial agents and may prevent foodborne outbreaks resulted from consumption of the cig kofte. It can be stated that yoghurt and yoghurt serum could be used as an antimicrobial system to lower the growth of microbial loads of the cig kofte samples. Additionally, yoghurt and yoghurt serum can be applied in the cig kofte to improve nutritional values and to soften their strong flavoring characteristics.

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