Several quality attributes of beef and turkey meat doner kebabs produced by traditional or continuous process

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Abstract The chemical, microbiological and sensory properties of doners produced by traditional or continuous processes were investigated. The production method (traditional or continuous) did not affect microbiological quality ($p < 0.05$). Doners produced by traditional process had generally better sensory properties than those produced by continuous process. Continuous process produced turkey meat doners with lesser fat content ($p < 0.05$), higher moisture content ($p < 0.05$). Even though, doners produced by the traditional process were given higher ratings by the sensory panel than those produced by the continuous process, the difference might not have any practical importance. Given the higher production capacity, continuous process is expected to replace traditional process in the years to come.

Keywords Beef doner kebab · Turkey meat doner kebab · Continuous process · Traditional process

Introduction

Muscle foods have a significant role in people's diet because they are good sources of vitamins and minerals. Rapid changes in people's lifestyles have increased the share of convenience foods in the overall food market. Doner kebab having different names such as gyro, donair, dona kebab, chawarma is a traditional meat product and is very popular in the Middle East, Asia, Europe, and many parts of the world (Kayışoğlu et al. 2003; Vazgeçer et al. 2004). To produce doner kebab, lamb,

veal, beef, chicken, ostrich or turkey meat may be used. The meat is mostly marinated with onion juice, tomato sauce, and yoghurt. Following the marination, the marinated meat is mixed with beef or sheep tallow. Then, the resulting mass is refrigerated for about 24 h in order to allow the meat and fat particles to stick together. After refrigeration, the raw doner is put on a vertical spit where it is slowly rotated so that it can evenly be cooked using a heating element powered by gas, charcoal, or electric. The cooked doner then becomes ready to be served and is generally served on a plate with a side dish or is enjoyed in bread sandwiches along with onions, tomatoes, herbs, salad or other dressing (Ergönül and Kundakçı 2007; Moeller et al. 1994; Todd et al. 1986).

Even though doner kebab is enjoyed in several places, there are some issues related to its microbiological quality and formulation. Using low quality raw meat and undercooking may bring up food safety issues. In fact, Jöckel and Stengel (1984) reported that enough heat treatment had to be given to raw doners because they were not microbiologically safe at all. They further reported that 10% of ready to eat doners they studied had *Clostridium perfringens*. Kruger and Davis (1999) detected 5.3–6.2 log cfu/g Staphylococci in 42% doner samples in another study. In another study, Dıgırak et al. (1995) reported an average 2.6×10^3 cfu/g *C. perfringens* in doner samples and they further reported that about 25% of the samples contained *Salmonella* spp. Therefore, they concluded that the hygienic quality of doner kebabs sold in Elazığ/Turkey was unsatisfactory. Similarly, an average of 1.7 – 3.0×10^5 cfu/g total bacteria count and 1.0 – 8.4×10^2 cfu/g *E. coli* were detected in doner samples sold in Erzurum/Turkey (Gençer and Kaya 2004). The microbiological safety issue of Turkish doner is not only related to raw material quality but it is also closely related to the way the doner is prepared. Most Turkish doners are produced in a traditional process where a person prepares the doner by hand. Alternatively, a novel

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continuous doner production process is developed where the doner is mostly prepared by machinery rather than hand. Therefore, the objective of this study is to evaluate and compare sensory, textural, chemical, and microbiological quality of beef or turkey meat doners prepared by either traditional traditional process or innovative continuous process.

Materials and methods

Beef and turkey meat doners were produced by a private leading meat processor (Pinar Meat Company, Izmir, Turkey) using either a traditional (traditional) or continuous process. For manufacturing turkey meat döner, turkey thigh meat, fat, spice mixture, salt and onion extract were used, whereas beef meat, tallow, spice mixture, salt and onion extract were used for manufacturing beef döner. In the continuous process, a tunnel heater was used which was designed by the staff of research and development department of Pinar Meat. Doners were cooked in a continuous tunnel heater at 220 °C until the temperature of the slices taken from the doner mass reached 90 °C, whereas in the traditional process, doners were cooked at 300 °C on vertically oriented grill until the temperature of the slices taken from the doner mass reached 90 °C. The formulations used were the standard commercial formulations of that processor.

The moisture, protein, fat, ash and cholesterol content and pH of the cooked doner samples were determined as described by AOAC (1990), Gökalp et al. (1995) and Sante and Fernandez (2000).

The color values of samples were evaluated with a colorimeter (Minolta, Osaka, Japan). *L*, *a*, and *b* (Hunter) parameters were measured. A white tile (*L*=93.3; *a*=0.3162; *b*=0.3321) was used as reference for the calibration. 10 measures were performed for each sample under each condition and then average values and standard deviations were determined (Gönül et al. 1998).

As for the microbiological analyses, total mesophilic aerobic count, total psychrophilic microorganism count, yeast and mold count, the numbers of *Clostridium perfringens*, *Escherichia coli* and *Staphylococcus aureus* were determined. *Salmonella* and *E.coli* O157:H7 counts of the samples were determined following the income of the raw meat (Pandey et al. 2010; Ünlütürk and Turantaş 2002).

To determine cholesterol content of the samples, 1 g of doner was taken into a test tube and 5 ml of 2 N KOH was added into it. Tube was shaken well for 15 s then kept in a water bath at 80 °C for 30 min by shaking 5 min intervals. Tube was cooled down under tap water and 1 ml of distilled water and 5 ml of hexane were added, then shaken for 1 min and centrifuged for 1 min at 2000 rpm. Upper phase was taken into a vial and analyzed in gas chromatograph type, number

(company, town, country). Temperatures of oven and the inlet detector were 285 °C and 300 °C respectively.

The shear force value (SFV) of the samples was determined using a texture analyzer type, number (Stable Micro Process, town, United Kingdom) having a WBSF head. Load cell was 50 kg, drive speed was 10 cm/min, and chart speed was 10 cm/min. The sample dimension was 3 cm (height)×3 cm (width).

Sensory properties including taste, ease of swallowing, appearance, juiciness, tenderness and overall likeness were determined on an 8-point hedonic scale. Sensory analysis was performed by a panel of 8 panelists. The panelists were faculty and research assistants of Food Engineering Department of Celal Bayar University (Manisa, Turkey) and were trained about the hedonic scale to be used and nature of the beef or turkey meat doner (Johnston and Karlström 1981).

Treatments included beef doner manufactured by the traditional process, beef doner manufactured by the continuous process, turkey meat doner manufactured by the traditional process, turkey meat doner manufactured by the continuous process. On a given day, each replicate was represented by 5 cooked samples taken from the production line. Research was replicated three times.

Statistical analysis

The design was completely randomized. Three replications were done. The analysis of variance was done using the PROC GLM procedure of SAS (company, town, country). LSMEANS for treatments were generated and separated when significant ($p<0.05$) using the Duncan procedure.

Results and discussion

The pH, protein, ash, and cholesterol content of the turkey meat doners were not affected ($p>0.05$) by the production method (Table 1). However, a lower ($p<0.05$) moisture and a higher ($p<0.05$) fat content was observed for the doners produced by the traditional process. This could be explained by the differences in the production process. Beef doners produced by the traditional process had higher ($p<0.05$) protein and lower ($p<0.05$) cholesterol content than those produced by the continuous process (Table 1). Production method (traditional or continuous) did not affect ($p>0.05$) pH, fat content, moisture content, and ash content of beef doners (Table 1).

Regardless of doner type (turkey meat or beef doners), continuous process yielded doners having higher *L** values (Table 1). This could be explained by the fact that direct exposure of doners to open fire for a long time was the case in the traditional process. On the other hand, continuous process gave lower *a** value for either turkey meat or beef doners. However, the difference was not significant ($p>0.05$).

Table 1 Quality of turkey meat and beef doner samples produced by the traditional or continuous method

	Turkey meat döner (traditional)	Turkey meat döner (continuous)	Beef döner (traditional)	Beef döner (continuous)
Chemical composition				
pH	6.2±0.10	6.0±0.04	6.2±0.14	6.2±0.005
Fat (%)	25.2±3.0 ^{a*} , **	17.8±1.50 ^b	23.3±1.80	18.2±3.90
Moisture (%)	47.1±1.50 ^a	56.5±1.50 ^b	49.0±2.50	55.9±1.10
Protein (%)	20.1±1.20	18.9±1.90	21.3±0.52 ^a	17.8±0.72 ^b
Ash (%)	2.6±0.06	2.4±0.35	2.8±0.28	2.4±0.21
Cholesterol (mg/100 g)	29.6±6.80	29.3±17.6	38.2±7.90 ^a	45.3±10.70 ^b
Hunter color values				
L*	47.9±3.10	52.8±1.10	45.1±0.07 ^b	53.4±1.30 ^a
a*	7.7±0.60	6.6±0.62	4.5±0.93	3.0±0.80
b*	24.9±0.29 ^b	26.2±0.63 ^a	19.3±0.14	20.3±1.40
Textural attributes				
Firmness (kg)	2.3±0.40 ^b	2.9±0.21 ^a	3.8±0.41 ^a	2.4±0.70 ^b
Toughness (kg.sec)	7.8±1.60 ^b	14.7±0.98 ^a	14.5±1.90 ^a	10.3±0.17 ^b
Sensorial scores				
Taste	5.9±0.19	5.5±0.25	5.3±0.38	4.9±0.07
Ease of swallowing	6.3±0.12 ^a	5.6±0.26 ^b	5.5±0.25	5.7±0.25
Appearance	5.7±0.07	5.6±0.68	5.8±0.26	5.3±0.33
Juiciness	6.2±0.54	5.7±0.07	5.4±0.31	5.8±0.38
Tenderness	6.4±0.14 ^a	5.3±0.31 ^b	5.5±0.19	5.5±0.33
Overall acceptability	6.3±0.19 ^a	5.4±0.31 ^b	6.2±0.19 ^a	5.4±0.14 ^b

* Means within a row having different letters are significantly different for the same meat type ($p < 0.05$)

** $n = 3$

On the contrary, for turkey meat doners, the continuous process gave higher ($p < 0.05$) b^* value than the traditional process.

For beef doners, the traditional process yielded higher ($p < 0.05$; 3.8 kg) firmness values than the continuous process (2.4 kg). Similarly, the traditional process yielded higher ($p < 0.05$; 14.5 kg-sec) toughness values than the traditional process (10.3 kg-sec). The same trend was observed for the turkey meat doners. The traditional process yielded higher ($p < 0.05$; 2.9 kg) firmness (WBSF) values than the continuous process (2.3 kg) (Table 1). Similarly, the traditional process yielded higher ($p < 0.05$; 14.7 kg-sec) toughness values than the traditional process (7.8 kg-sec). The higher toughness and firmness scores with the traditional process for either beef or turkey meat doners could be attributed to longer processing times and higher processing temperatures.

Microbiologically, production process (traditional or continuous) did not affect ($p > 0.05$) the quality of beef or turkey doner. Even though, targeted microbiological quality for beef or turkey meat doners was achieved by the continuous process, the doners produced by the traditional process had almost the same microbiological quality. The microbial quality of doner kebabs in our study

was much better than that of doner kebabs in other studies (Gençer and Kaya 2004; Kayışoğlu et al. 2003; Vazgeçer et al. 2004). Kayışoğlu et al. (2003) reported that, *Salmonella* was detected in 80% of the chicken meat döner and in 40% of the beef döner consumed in Tekirdağ province. According to Vazgeçer et al. (2004), TMAB counts of the döner samples changed from 2 to 5.81 log cfu/g, whereas *E. coli* and *Clostridia* were detected in 31% and 7% of the samples, respectively.

It was found that, total mesophilic aerobic bacteria (TMAB) counts of the beef and turkey meat doners manufactured by continuous process were 2.2 log cfu/g and 1.5 log cfu/g respectively, whereas these values were 2.3 log cfu/g and 1.1 log cfu/g for beef and turkey meat doners manufactured by traditional method. Average TMAB counts of beef doners were higher than those of turkey meat doners. Total psychrophilic bacteria counts were found as < 1 log cfu/g, 2.0 log cfu/g, 1.1 log cfu/g and 1.4 log cfu/g for the samples turkey meat döner (traditional), turkey meat döner (continuous), beef döner (traditional) and beef döner (continuous) respectively.

Total yeast and mould counts of 3 samples (turkey meat döner—traditional, turkey meat döner—continuous and beef döner—traditional) were less than 1.0 log cfu/g, whereas the

average yeast and mould count of beef döner—continuous was 1.4 log cfu/g.

Coliforms, *E.coli* *S.aureus* and *C.perfringens* could not be detected. Absence of coliform bacteria, *E.coli*, *Clostridium perfringens* and *Staphylococcus aureus* indicates that the hygienic quality of doner samples is acceptable. Moreover, *Salmonella* and *E.coli* O157:H7 were not detected in the raw meat and tallow. For cooked samples these analyses were not repeated, since raw material was free of these pathogenic bacteria.

As far as sensory results were concerned, turkey meat doners produced by the traditional process had better ease of swallowing ($p<0.05$), tenderness ($p<0.05$) and overall acceptability ($p<0.05$) scores than those produced by the continuous process (Table 1).

Similar results were observed for beef doners. Sensory panel scores were mathematically in favor of beef doners produced by the traditional process. Overall acceptability of beef doners produced by the traditional process was higher ($p<0.05$) than that of beef doners produced by the continuous process.

Even though, doners produced by the traditional process were given higher ratings by the sensory panel than those produced by the continuous process, practically, the difference might not be considered important and might not even be perceived by the consumers.

Using the data obtained from sensory panel, it is clear that some modifications to the continuous process are needed. By possibly changing doner formulations and/or by adjustments in the production line to compensate for the lost characteristic doner flavor, the quality of the doners produced by the continuous process may match the quality of those produced by the traditional process.

In doing so, beef or turkey meat doners will be produced at a higher production rate without losing any sensory property. This will also increase profitability.

Conclusions

For a doner to be acceptable by a consumer, microbiological quality is as important as eating quality. As seen from results, microbiological counts of the samples produced by traditional and continuous processes were nearly the same. On the other hand, continuous doner production process offers the advantage of high production capacity, which may make its acceptance by the meat processing industry easier. It is thought that, besides these findings, continuous doner manufacturing

system should be optimized and used for doner manufacturing in terms of “high efficiency”.

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