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EVALUATION OF THE SANITARY STATUS OF RETAILED CAMEL MEAT-PRODUCTS WITH AN IMPROVEMENT TRIAL USING *Nigella sativa* AND *Capsicum annuum* OILS

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ABSTRACT

This study was undertaken to investigate the hygienic status of the camel meat cuts in comparison with three camel meat-products namely, camel mince, camel burger and camel sausage retailed in the butchery shops and grocery stores in Saudi Arabia. Evaluation of the sanitary status of these products were done via estimation of total bacterial count (TBC), total psychrophilic count (TPsC), most probable number (MPN) of coliforms, total Staphylococcus count (TSC) and total mold count (TMC). A trial for improvement of the sanitary status of the camel mince was conducted using *Nigella sativa* and *Capsicum annuum* oils at different concentrations. The achieved results indicated unsatisfactory sanitary status of the retailed camel meat products in the study area, in terms of high microbial counts. In particular, camel mince had significantly the highest counts; while camel sausage was the lowest one. A clear and significant reduction for the microbial load was achieved after treatment of the formulated camel meatballs from camel mince with *Nigella sativa* and *Capsicum annuum* oils, particularly at 2%.

Key words: Camel meat, *Capsicum annuum*, Microbial load, *Nigella sativa*

The industry of camel meat products increased worldwide, particularly in the Middle East (Kadim *et al,* 2008; El-Ghareeb *et al,* 2019). Meat-products are popular foods for a large section of the country population, particularly among children because of their unique aroma and flavour (Fratianni *et al,* 2010).

The world annual production of camel meat reached 39,606 tonnes for the year 2017 with annual consumption of 0.42kg per capita (FAOSTAT, 2018). With its relatively lower and affordable price, camel meat is a suitable alternative to cattle meat and can significantly contributes to achieving the food security in developing countries where there is growing demand for red meat.

The contamination of the meat products may occur during processing or may be due to the use of contaminated raw material, since some bacteria that form part of the natural flora of cattle are pathogenic for humans as well (Aberle *et al,* 2001; Darwish *et al,* 2015). Therefore, there is a large need to confirm the sanitary status of the retailed meat and meat products in Saudi Arabia.

Spices represent promising tools for reducing the microbial load in meat and meat-products (Jessica Elizabeth *et al,* 2017). Spices and herbs are commonly used in the industry of the meat products for the development of their unique aroma and flavour, to give attractive colours, and for their antimicrobial activities (Aziz and Karboune, 2018). However, the effects of the black seed (*Nigella sativa*), and capsicum (*Capsicum annuum*) to improve the sanitary status and reduce the microbial load of the camel meat-products had received little attention.

In present study we investigated the sanitary status of the camel meat cuts in a comparison with three meat-products namely, camel mince, camel burger, and camel sausage. A trial for improvement of the sanitary status of the camel mince was conducted using *Nigella sativa* and *Capsicum annuum* oils at different concentrations.

Materials and Methods

Eighty samples were collected randomly and equally from camel meat cuts and three meat-

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products retailed in the butchery shops and grocery stores in Al-Ahsa, Saudi Arabia. The examined meat products were camel mince, camel burger and camel sausage (n = 20 each, each sample weighs 100 g). The collected samples were transferred cooled directly without delay to the laboratory for microbiological examination.

Organoleptic examination for the examined samples was conducted using the method of Varnam and Sutherland (1995). Samples with brick-red colour, fresh odour and firm consistency were considered normal.

Samples were prepared for microbiological examinations according to the technique recommended by APHA (2001). Total bacterial count (TBC) was estimated using the method of APHA (2001).

TBC/g = average No. of colonies × reciprocal of dilution Counted colonies expressed as log cfu/g.

For estimation of the total psychrophilic count (TPsC), the pour plate technique recommended by APHA (2001) was applied using standard plate count agar medium and incubated at 7ºC for 10 days. Results were calculated and recorded in the same way as TBC. Counted colonies were expressed as log cfu/g.

Most probable number (MPN) of Coliforms was determined by three tubes most probable number (MPN) method (APHA, 2001). The most probable number of coliforms was calculated according to the recommended tables.

Total *Staphylococcus aureus* count (TSC) was determined by the method of Quinn *et al* (2011), using Baird Parker agar (Biolife, Italy) supplemented with egg yolk-tellurite emulsion (Himedia, India).

TSC/g = average No. of colonies × reciprocal of dilution.

Total mold counts were determined by the pour plate technique using Sabouraud's dextrose agar medium (Oxoid, Basingstoke, UK) supplemented with chloramphenicol 100 mg/L followed by incubation in dark at 25ºC for 5-7 days. During the incubation time, the plates were examined daily for mold growth. Estimation of total mold count was obtained by direct counting of the cultured plates (Vanderzant and Splittstroesser, 2001).

TMC/g = average No. of colonies × reciprocal of the dilution.

Improvement of the microbial status of the camel minced meat was done by using *Nigella sativa* and *Capsicum annuum* oils at different concentrations. Five of the collected minced meat samples (250 g/each) were formulated as meatballs (5 balls from each sample, 50g/each). Formulated meat balls were grouped into 5 groups, namely, group 1 which was immersed in corn oil for 30 min and served as a control; group 2 which was immersed in Nigella oil at 0.5% for 30 min; group 3 which was immersed in Nigella oil at 2.0% for 30 min; group 4 which was immersed in capsicum oil 0.5% for 30 min; group 5 which was immersed in capsicum oil 2% for 30 min. Microbiological examination was conducted as mentioned before.

All values were expressed as means ± SE, and all measurements were carried out in duplicates. Microbial counts were converted into base logarithms of colony forming units per g (log cfu/g). Statistical significance was evaluated using One way analysis of variance (ANOVA), followed by the Tukey–Kramer HSD post hock test.

Results

Organoleptic examination of the collected samples revealed that all samples had normal sensory parameters. The obtained results for microbiological examination of the collected samples in this study declared that the mean values of TBC were 5.43 ± 0.26, 4.53 ± 0.15, 4.64 ± 0.19, and 4.32 ± 0.08-log cfu/g in the examined camel mince, camel meat cut, camel burger, and camel sausage, respectively (Fig 1A).

The mean concentrations of TPsC in the examined camel mince, meat cut, burger, and sausage were 3.96 ± 0.22, 3.59 ± 0.21, 3.34 ± 0.07, and 3.12 ± 0.09-log cfu/g, respectively (Fig 1B).

Most probable number of coliforms (MPN) were 2.72 ± 0.09, 2.27 ± 0.04, 2.38 ± 0.05, and 2.25 ± 0.05-log MPN/g in the examined camel mince, meat cut, burger, and sausage, respectively (Fig 2A).

The average TSC in the examined samples were 3.27 ± 0.19, 2.94 ± 0.12, 2.68 ± 0.09, and 2.51 ± 0.06-log cfu/g in the examined camel mince, camel meat cut, camel burger, and camel sausage, respectively (Fig 2B).

The average counts for the total mold in the examined camel mince, camel meat cut, camel burger, and camel sausage were 3.61 ± 0.24, 3.16 ± 0.13, 3.09 ± 0.13, and 2.62 ± 0.13-log cfu/g, respectively (Fig 3).

In an improvement trial for the sanitary status of camel mince, *Nigella sativa*, and *Capsicum annuum* oils at 0.5%, and 2% were used. The achieved results in Table 1 declared that TBC in the formulated

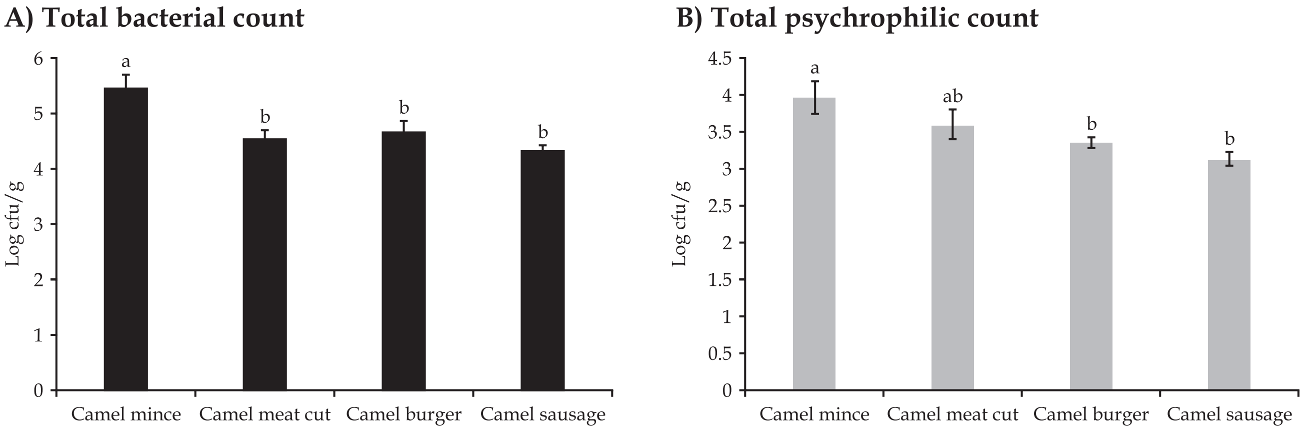

Fig 1. Total bacterial and psychrophilic counts in retailed camel meat products. **A**) Total bacterial count, **B**) Total psychrophilic count. Values represent means ± SE (Log cfu/g) of camel meat cuts, camel mince, camel burger, and camel sausage (n = 20/ each). Columns carrying different superscript letter differ significantly among examined samples at $P < 0.05$.

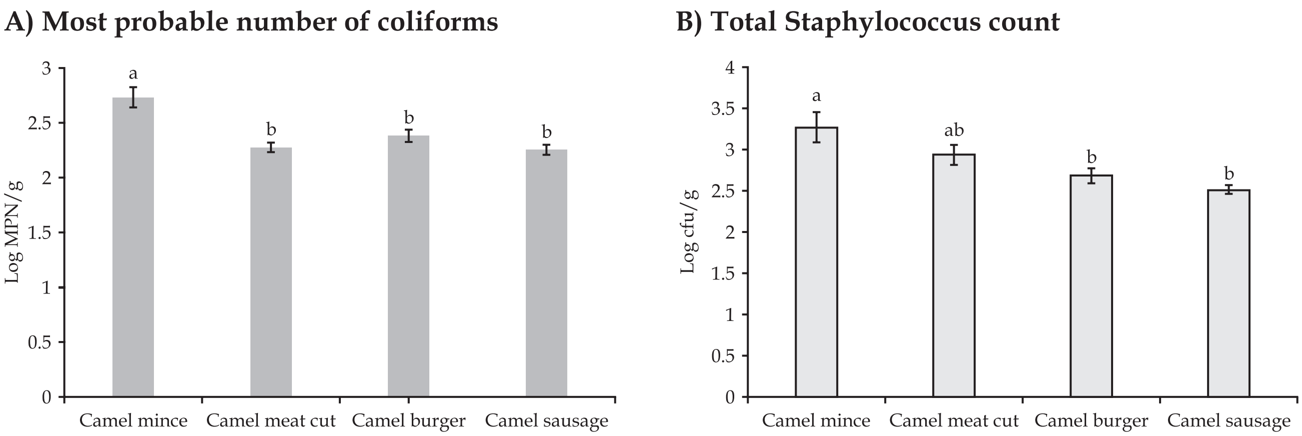

Fig 2. Most probable number of coliforms and total Staphylococcus count in retailed camel meat products. **A**) Most probable number of coliforms **B**) Total Staphylococcus count. Values represent means ± SE (Log cfu/g) of camel meat cuts, camel mince, camel burger, and camel sausage (n = 20/ each). Columns carrying different superscript letter differ significantly among examined samples at $P < 0.05$.

meatballs from the camel mince was significantly reduced by 19.13%, 26.80%, 29.17%, and 38.02% after treatment with Nigella oil 0.5%, Nigella oil 2%, Capsicum oil 0.5%, and Capsicum oil 2%, respectively. Total psychrophilic counts were reduced by 25.88%, 33.34%, 28.07%, and 36.09% after treatment with Nigella oil 0.5%, Nigella oil 2%, Capsicum oil 0.5%, and Capsicum oil 2%, respectively. These treatments improved the most probable number of coliforms by 11.93%, 18.60%, 14.99%, and 26.29%, respectively; TSC by 16.33%, 20.43%, 19.23%, and 27.78%, respectively; and TMC by 10.81%, 20.61%, 14.90%, and 23.89%, respectively.

Discussion

Camel meat is considered as relatively new and emerging source for the animal-derived protein (El-Ghareeb *et al,* 2019). Meat-products such as mince, burger and sausage are preferred by a large section of the population because of their specific aroma and flavour, and their easy preparation. Sanitary status of the retailed camel meat and meat-products reflects the hygienic measures performed during handling and processing of such products and affect the microbiological quality and the shelf life of the end products (Tang *et al,* 2020). In addition, one major task for the food hygiene sector is to confirm the microbial quality of the retailed meat and meat-products. Different microorganisms have been used as indicators of the level and source of contamination of meat and meat products during animal slaughtering or meat products manufacturing. For instance, total aerobic count used to evaluate the overall degree of microbial contamination (Aberle *et al,* 2001). Coliforms, and other Enterobacteriaceae, are indicative of post-processing faecal contamination (Dogan-Halkman *et al,* 2003). Contamination of raw

Table 1. Improvement of the sanitary status of the camel mince using Nigella and capsicum oils.

	TBC		TPsC		MPN		TSC		TMC	
	Mean ± SE	Reduction %	Mean ± SE	Reduction %	Mean ± SE	Reduction %	Mean ± SE	Reduction %	Mean ± SE	Reduction %
Control	5.09 ± 0.39[a]	0	3.79 ± 0.52[a]	0	2.92± 0.19[a]	0	2.94 ± 0.19[a]	0	3.67 ± 0.06[a]	0
Nigella 0.5%	4.12 ± 0.09[b]	19.13	2.81 ± 0.09[ab]	25.88	2.58 ± 0.07[ab]	11.93	2.46 ± 0.07[b]	16.33	3.27 ± 0.11[b]	10.81
Nigella 2.0%	3.73 ± 0.24[bc]	26.80	2.53 ± 0.08[b]	33.34	2.38 ± 0.08[b]	18.60	2.34 ± 0.04[b]	20.43	2.91 ± 0.11[bc]	20.61
Capsicum 0.5%	3.61 ± 0.11[bc]	29.17	2.73 ± 0.12[b]	28.07	2.49 ± 0.06[ab]	14.99	2.37 ± 0.04[b]	19.23	3.12 ± 0.07[bc]	14.90
Capsicum 2%	3.16 ± 0.09[c]	38.03	2.43 ± 0.11[b]	36.09	2.16 ± 0.09[b]	26.29	2.12 ± 0.07[b]	27.78	2.79 ± 0.09[c]	23.89

Values within the same column carrying different superscript letter are significantly different at P< 0.05.

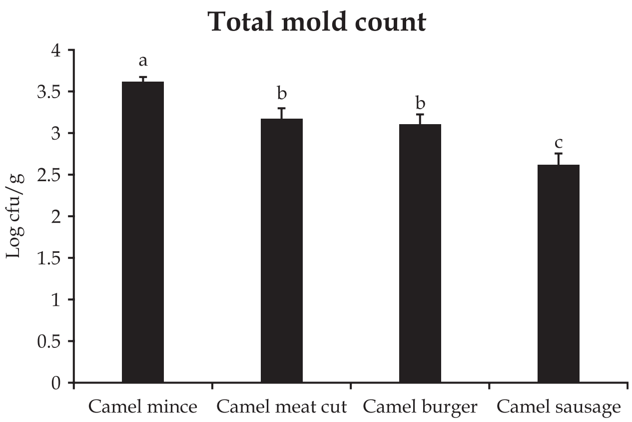

Fig 3. Total mold count in retailed camel meat products. Values represent means ± SE (Log cfu/g) of camel meat cuts, camel mince, camel burger, and camel sausage (n = 20/ each). Columns carrying different superscript letter differ significantly among examined samples at P < 0.05.

meat with *Staphylococcus aureus* is not un-common because of its inhabitance of human and animal skin as well (Adams and Moss, 1997). Thus, it is highly recommended to investigate the hygienic status of the retailed camel meat and meat-products on a regular basis. In the present work, microbial indicators for the sanitary status of the camel meat and meat-products such as TBC, TPsC, MPN of coliforms, TSC, and TMC were estimated. These indicators enables us to give correct decision about the hygienic practices adopted during product handling and processing, and subsequently accepting or rejecting the final products (Mossel *et al,* 1995).

The obtained results in the present study declared unsatisfactory sanitary status for the retailed camel meat and meat-products, in terms of high TBC, TPsC, MPN of coliforms, TSC, and TMC. In particular, camel mince had significantly (P <0.05) the highest counts followed by camel meat cuts, camel burger, and camel sausage, respectively. Similarly, unsatisfactory hygienic measures for camel meat collected from abattoir and retail houses in Jigjiga city, Ethiopia (Tegegne *et al,* 2019). Furthermore, Tang *et al* (2020) recorded higher counts for the microbial indicators in the camel meat and retailed edible offal collected from local markets in Egypt. However, Corrò *et al* (2012) reported that Enterobacteriaceae counts were below the detection limits in the slaughtered camels in the Sahrawi refugee camps located in southwestern Algeria. Camel meat was considered as a possible source for the transmission of the specific food-borne pathogens such as *Campylobacter* spp. in Iran (Rahimi *et al,* 2010), Enterohaemorrhagic *Escherichia coli* O157:H7 in Fars and Khuzestan provinces, Iran (Rahimi *et al,* 2012), Methicillin resistant and susceptible *S. aureus* in Riyadh, Saudi Arabia (Raji *et al,* 2016), *Clostridium difficile* in Iran (Rahimi *et al,* 2014), and vancomycin-resistant *S. aureus* in Egypt (Al-Amery *et al,* 2019). The achieved high microbial load may attributed to lack of hygienic conditions during different stages of meat handling including storage and processing. Cross-contamination also play a vital role in increasing the level of contamination either via worker's hands, cutting boards, knives and even water during slaughtering, evisceration and manufacturing of camel meat and meat products. Meat contaminated with mold has the potential of public health hazard because of the production of mycotoxins with their carcinogenic effect, ability to cause liver diseases and organs failure (Darwish *et al,* 2014). The high bacterial counts in the camel mince are reasonable as mincing process of meat with ingredients other than the meat itself may lead to increasing the microbiological load of the produced mince. Furthermore, mincing machine is considered as a possible source of transferring foodborne pathogens from contaminated meat to non-inoculated ones (Papadopoulou *et al,* 2012).

In a trial to reduce the microbial load in the camel mince, *Nigella sativa* and *Capsicum annuum* oils were used. Interestingly, a significant reduction for the microbial load was achieved, in terms of reduction of TBC, TPsC, MPN of coliforms, TSC, and TMC. Both of *Nigella sativa* and *Capsicum annuum* oils improved the microbial quality in a concentration-dependent manner, with the highest reduction rate achieved with *Capsicum annuum* 2% without any change in the sensory characters of the final meat-product. *Nigella sativa* is also known as black seed or black cumin, has many pharmacological properties. Thymoquinone (TQ) is the most abundant constituent of the volatile oil of *Nigella sativa* and both of *Nigella sativa* and TQ have a broad antimicrobial spectrum including Gram-negative, Gram-positive bacteria, viruses, parasites, Schistosoma, and fungi (Forouzanfar *et al,* 2014; Tavakkoli *et al,* 2017). Furthermore, *Nigella sativa* seed extracts and oils were shown to have antimicrobial effects against fungi such as *Aspergillus fumigatus, Aspergillus flavus,* and aflatoxin production (Khosravi *et al,* 2011); and Methicillin resistant *S. aureus* (Gawron *et al,* 2019). Capsaicin is an active component of plants of the Capsicum genus, and it is commonly used as a food additive for pain relief, weight loss, body thermoregulation, and antioxidant, antimicrobial and anticancer activities (Adaszek *et al,* 2019). Capsicum extracts were also found to have antifungal activities (de Azevedo Dos Santos *et al,* 2020). The antimicrobial effects of the *Capsicum annuum* might be attributed to the high content of vitamin C, phenols and carotenoids (Al Khalaf *et al,* 2020).

In conclusion, strict hygienic precautions should be adopted during handling, processing, transportation and distribution of camel meat and meat-products. In addition, treatment of the camel meat and meat-products are of value in improving their microbial quality.

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