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The Quality Characteristics of Camel Sausage Formulated with Different Levels of Whey Protein Powder

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Abstract*—In this study camel sausage was formulated with different levels (1, 2, 3 and 4%) of whey protein powder (WPP). Raw and cooked sausage samples were evaluated for physical properties, cooking measurements, shrinkage, color parameters, emulsion capacity (EC) and emulsion stability (ES) and sensory attributes. Using whey protein powder increased pH value, moisture retention, emulsion capacity and emulsion stability while, the cooking loss and shrinkage were decreased. Camel sausages formulated with 4% whey protein powder (WPP) had higher emulsion stability and emulsion capacity, lower cooking loss, better color and more acceptable than other sausage samples. However addition of 4% whey protein powder can be improved the quality characteristics of camel sausages.*

***Keywords*— Camel sausage; Whey protein; Quality characteristics.**

I. INTRODUCTION

Camels are used for many purposes such as meat and/or milk production, and for physical labour as well as racing. Camel meat is known to be more beneficial for health because it contains lower fat and cholesterol levels than other red meats (Gheisari and Ranjbar, 2013). The mineral and proximate composition of camel meat from young male camels (1-3 years) was generally similar to the amounts reported for these constituents in the corresponding tissues of beef (El Faer *et al.*, 1991and Mansour & Ahmed, 2000).Generally; consumers are prejudiced against fresh camel meat. If camel meat could be converted into processed products such as burger and sausage, it might be more acceptable to domestics' consumers. (Mansour& Ahmed, 2000).However, the important technological problem in manufacturing of camel meat products is the poor emulsifiability of camel fat. The high amount of connective tissue also makes camel meat a challenging raw material for producing a stable emulsion (Ulmer *et al.*, 2004).

Dairy products are widely used to improve the functional properties of meat products. Addition of whey protein improve the water holding capacity, increase juiciness of the final product, emulsion stability, provide better color properties and lowering chewiness and elasticity (Keaton, 1999). This study aims to evaluate the quality characteristics of camel sausages formulated with different levels of whey protein powder.

II. MATERIALS AND METHODS

Preparation of camel sausage

Camel meat and humped fat obtained from local slaughter house were used in this study. Left round (*Biceps femoris* muscles) of 3-4 years aged camel were pooled to form an experiment unit, with three (batches) of lean ground meat being prepared from each sausage formulation. All knives – separable fat was removed from muscles and used with humped fat as fat source. Lean meat was ground through a 3mm plate grinder. The ground meat was transferred to bowl chopper and the following additives (whey protein powder, fat, spices, salt, onion and ice) were added and mixed as given in Table (1). Each formula was transferred to sausage machine and stuffed into natural sausage casings (sheep intestines). Sausage was tiered into 10 cm length and placed in plastic foam trays, packed in polyethylene bags and frozen at -18ºC±1 until analysis.

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Table.1: Camel sausage formulation with whey protein powder

Ingredients (%)	Treatments				
	Control	WPP1	WPP2	WPP3	WPP4
Camel fat	10	10	10	10	10
Whey protein powder (WPP)	0	1	2	3	4
Onion	5	5	5	5	5
Salt	2	2	2	2	2
Spices	1.2	1.2	1.2	1.2	1.2
Ice	1	1	1	1	1

WPP 1, 2, 3, 4: Sausage formulated with whey protein powder at levels1, 2, 3 and 4%

pH and emulsion properties

pH of raw camel sausages was measured as described by Hood(1980). Five replicates were done for each treatment. Emulsifying capacity and emulsion stability of sausage were evaluated according to the method of Antipova *et al*. (2001). Three measurements were done for each treatment.

Cooking measurements and physical properties

Sausages were roasted in a preheated oven for 10 min. All cooking measurements were carried out on five replicates of each treatment as reported by Naveena et al. (2006) as follows:

Cooking loss (%):= (Uncooked sample weight) - (Cooked sample weight)/ (Uncooked sample weight) ×100

Cooking yield (%): = (Cooked sample weight) / (Uncooked sample weight) ×100

Moisture retention % was determined according to El-Magoli *et al.* (1996).Five replicates were done for each treatment. Moisture retention (%): = Cooking yield % × Moisture in cooked sample % /100

Moisture content was determined according to A.O.A.C (2000).

Water holding capacity (W.H.C) and plasticity were measured using the method of Wierbicki and Deatherage (1958). Five replicates were done for each treatment. Data were presented as cm^2 as described by Russo *et al.* (1999).

Shrinkage measurements

Raw and cooked samples were measured for width and length as described by Berry (1993) using the following equation:

Reduction in width (%) = (Uncooked sample width) - (Cooked sample width) / (Uncooked sample width) ×100

Reduction in length (%) = (Uncooked sample length) - (Cooked sample length)/(Uncooked sample length) ×100

Dimensional shrinkage % was calculated using the following equation as reported by Murphy *et al.* (1975). = [(Raw length - Cooked length) + (Raw width - Cooked width)] / (Raw length +Raw width) ×100

Color measurements

Meat color was measured by Chroma meter (Konica Minolta, model CR 410, Japan) calibrated with a white plate and light trap supplied by the manufacturer. Color was expressed using the CIE L, a, and b color system (CIE, 1976). Five replicates were used per each treatment.

Sensory evaluation

Camel sausage was subjected to organoleptic evaluation as described by A. M. S. A. (1995). Ten panelists of staff members of Food Sciences Department, Faculty of Agriculture, Ain-Shams University were scored appearance, texture, juiciness, flavor, tenderness and overall acceptability using a 9-point hedonic scale. The mean scores of the obtained results of organoleptic evaluation were then statistically analyzed.

Statistical analysis

All data generated from each experiment were analyzed using statistical analysis system (SAS, 2000). Treatments were compared using the Duncan's multiple range test method for significant main effects at $P < 0.05$.

III. RESULTS AND DISCUSSION

pH value and emulsion properties

From data shown in Table 2. It can be found that all sausage samples formulated with whey protein powder (WPP) had higher pH value compared to control one, but the difference between formulated sausage samples was slightly significant. (Yetim *et al.*, 2006) showed slight but not significant ($P > 0.05$) increase in pH value of sausages with increasing whey substitution. Also, (Serdaroglu, 2006) reported that pH value of meatballs formulated with 2 or 4% whey protein (WP) were not significantly different at different levels of fat.

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Table.2: Emulsion properties and pH value of camel sausage

Treatment	pH	Emulsifying capacity (%)	Emulsion stability (%)
Control	5.81^{c}	60.00^{c}	32.00^{d}
WPP1	5.90^{ab}	65.75^{b}	32.50^{d}
WPP2	5.86^{bc}	67.50^{b}	38.40^{b}
WPP3	5.88^{ab}	78.00^{a}	34.37^{c}
WPP4	5.94^{a}	79.50^{a}	40.50^{a}

$^{a-d}$ means within the same column with different superscripts letters are different ($p<0.05$).

The same results were obtained by Serdaroğlu and Özsümer (2003) they reported that no significant differences in pH values of batters or finished beef sausages formulated with different levels of whey protein and fat. Whey protein powder had a significant effect on emulsion capacity. Camel sausage formulated with whey protein had higher emulsion capacity than control one. In addition, emulsion capacity increased with the increasing of whey protein level. Data of pH value are consistency with the results of emulsion capacity % of camel sausage samples, which mean that emulsion capacity increased with the increasing of pH value and whey protein level. These results are coincided with (Kurt & Zorba, 2005) they reported that addition of whey protein significantly increased the protein concentration and emulsion capacity. Also, they concluded that pH value had much higher effect than protein concentration on emulsion capacity of different type of meats (beef, turkey and chicken).Sausages formulated with whey protein powder had the higher emulsion stability (ES) than control one. Camel sausages formulated with 2 or 4% WPP had the higher emulsion stability than the other sausage samples. These results are close to that obtained by Serdaroğlu and Özsümer (2003) they found that addition of WP increased the ES of beef sausage formulated with different fat levels. In addition Kurt & Zorba (2005) reported that using WP increased significantly the emulsion stability of different type of meats (beef, turkey& chicken). These may be due to that addition of whey protein powder increased fat binding in the meat system even at lower fat levels (El-Magoli *et al.,* 1996) or the fact that whey proteins have a high capacity to bind water; i.e. high hydrophilic properties (Kocak & Aydemir, 1994).

Cooking parameters and physical properties

Data in Table 3.Showed that whey protein had a significant effect on the cooking loss of camel sausage. The lowest cooking loss was found in sausage formulated with 4% followed by sausage with 2% whey protein. No significant differences were found in sausages with 1% WPP and control. Sausage with 3% WPP had the highest cooking loss. These results are close to that obtained by Serdaroğlu (2006) which found that meatballs prepared with 2 or 4% whey protein were significantly higher for cooking yield at different fat levels. Also, Hale *et al.* (2002) found that beef patties containing textured whey protein had the lowest cooking loss than control one. In addition, Andiç *et al.* (2010) reported that addition WP improved the cooking yields of beef patties. They also found that patties formulated with 2% WP had the highest cooking yield. Sausage formulated with 1, 2 or 4% WPP had the highest moisture retention. Serdaroğlu (2006) found that addition of 2 or 4% whey protein to meatballs formulated with 5, 10, and 20 %fat significantly increased the moisture retention at each fat level. The same result was found by Andic *et al.* (2010) they noticed that beef patties formulated with 1 or 2% whey protein had higher moisture retention than the other patties.

Table.3: Cooking parameters and physical properties of camel sausage

Treatment	Cooking loss (%)	Moisture retention (%)	W.H.C (cm^2)	Plasticity (cm^2)
Control	44.45^{ab}	24.61^{b}	8.64^{a}	2.92^{c}
WPP1	43.64^{ab}	27.32^{a}	8.26^{a}	2.88^{c}
WPP2	42.34^{b}	27.35^{a}	4.74^{c}	3.60^{ab}
WPP3	44.86^{a}	24.19^{b}	6.62^{b}	3.04^{bc}
WPP4	40.13^{c}	27.48^{a}	3.00^{d}	4.04^{a}

$^{a-d}$ means within the same column with different superscripts letters are different ($p<0.05$).

Data in Table3.Represented a significantly improve in water holding capacity of camel sausage formulated with whey protein powder as compared to control one. The highest score of plasticity was found in sausage sample formulated

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with 4% WPP. These results are close to that obtained by Abdolghafour & Saghir (2014) who found a significantly increase in water holding capacity (WHC) of buffalo sausage formulated with different levels of whey protein powder as compared with control one. The same results were found by Serdaroğlu and Özsümer (2003) they reported that addition of whey protein increased WHC of beef sausage formulated with different levels of fat. Results of WHC were coincided with the results of cooking loss of camel sausage. Therefore, it can be concluded that addition of whey protein powder increased the WHC which cause a significant decrease in cooking loss%

Shrinkage measurements

Results of the reduction in width, length and shrinkage % of camel sausages were given in Table 4. Sausage formulated with 2 or 4% WPP had the lowest reduction in width, no significant differences were found in other sausage groups. Also, it can be noticed that sausage formulated with 4%WPP and control samples had the lowest reduction in sausage length. A slight difference was found between other sausage samples. All sausage samples trend to shrink during cooking process. Sausage formulated with 4% WPP recorded the lowest shrinkage %, while sausages of 3% WPP had the highest shrinkage %. A difference between the other sausage samples was not significant. Kumar and Sharma (2003) found that the higher reduction in diameter was found in control and the lowest reduction found in low-fat patties formulated with 10 % milk co- precipitates.

Table.4: Shrinkage measurements of camel sausage

Treatment	Reduction in width (%)	Reduction in length (%)	Shrinkage (%)
Control	23.71^{a}	10.99^{c}	13.40^{b}
WPP1	25.17^{a}	12.06^{bc}	13.39^{b}
WPP2	13.53^{b}	13.91^{ab}	13.79^{b}
WPP3	21.33^{a}	14.82^{a}	16.13^{a}
WPP4	15.73^{b}	10.98^{c}	11.82^{b}

$^{a-c}$ means within the same column with different superscripts letters are different ($p<0.05$).

The gain in height of patties was increased with increasing level of incorporation amongst the low-fat products. The shrinkage percent was indirectly proportional to the level of incorporation of milk co-precipitates with maximum shrinkage in the control group and minimum in the low-fat patties with 10 % milk co-precipitates. Also, El-Magoli *et al.*(1996) found that addition of increasing levels of whey protein concentrate (WPC) to low fat beef patties resulted in a linear decrease in shrinkage.

Color measurements

The effects of whey protein level on color attributes of fresh camel sausages were shown in Table 5. Sausages formulated with 4% WPP had the highest *L** value followed by sausage with2%.

Table.5: Color measurements of camel sausage

Treatment	*L**	*a**	*b**
Control	40.23^{c}	8.78^{b}	6.48^{d}
WPP1	39.90^{c}	9.26^{a}	8.66^{a}
WPP2	41.00^{b}	9.26^{a}	7.93^{b}
WPP3	40.36^{c}	9.14^{ab}	7.02^{c}
WPP4	43.70^{a}	9.01^{ab}	8.88^{a}

$^{a-d}$ means within the same column with different superscripts letters are different ($p<0.05$).

No significant differences were found in other samples. The lowest *a** value was found in control samples, slight differences were found between all sausage samples formulated with WPP at different levels. Control sample had the lowest *b** value than sausages formulated with whey protein. These results are close to that obtained by Yetim *et al.*(2006) who found that sausages formulated with different level of liquid whey protein had higher *L*,a** and *b** values compared with control one. These results go in parallel to that obtained by Abdolghafour & Saghir (2014).

Sensory evaluation

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From data in Table 6. It can found that sausage formulated with 4% WPP recorded the highest score for appearance followed by sausage formulated with 1 and 3% WPP. A slight difference was found in other sausages sample. Also, sausage with 4% WPP had the highest score for texture and no significant differences were found in the other sausage samples.

Table.6: Sensory evaluation of camel sausage

Treatment	Appearance	Texture	Juiciness	Flavor	Tenderness	Overall acceptability
Control	7.33^{b}	7.33^{b}	7.33^{b}	7.22^{b}	7.00^{b}	7.22^{b}
WPP1	7.90^{ab}	7.40^{b}	7.40^{b}	7.70^{b}	7.90^{ab}	7.40^{b}
WPP2	7.20^{b}	7.20^{b}	7.20^{b}	7.00^{b}	7.20^{b}	6.80^{b}
WPP3	8.30^{ab}	7.60^{b}	8.10^{ab}	6.60^{b}	7.10^{b}	7.50^{b}
WPP4	8.77^{a}	9.11^{a}	8.88^{a}	9.44^{a}	8.66^{a}	8.88^{a}

$^{a-b}$ means within the same column with different superscripts letters are different ($p<0.05$).

The high score for juiciness was recorded in sausage formulated with 4% WPP followed by sausage with 3% WPP and no significant differences were found in the other sausage samples. Sausage formulated with 4% WPP was more tender, more flavor and more acceptable than all sausage samples. Generally, sausage formulated with 4% WPP had the highest score for all sensory attributes and no significant differences were recorded between the other sausage samples. These results are close to that found by El-Magoli *et al.*(1996) they reported that sensory analysis showed the 4% WPC level to be preferred over lower levels with respect to juiciness and overall acceptability. Serdaroğlu (2006) reported that panels were not able to detect the addition of WP in meatball samples. Also, Andic *et al.*(2010) they found no significant differences in appearance, interior color, juiciness and flavor scores of patties formulated with 1% and 2% WP. The same results were found by Abdolghafour & Saghir (2014).

IV. CONCLUSION

Addition of whey protein powder significantly improved the quality characteristics of camel sausage formulated with 4% WPP and showed the highest emulsion capacity and emulsion stability, in addition to the highest score of flavor, tenderness and overall acceptability. Whey protein powder (WPP) can be used in camel sausage formula to improve the quality characteristics of the product.

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