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EFFECT OF WHEY PROTEIN CONCENTRATE ON THE QUALITY OF CHICKEN MEAT PATTIES DURING STORAGE AT 4°C

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SUMMARY

Whey protein concentrate at levels of 2 and 4% was added to chicken meat patties formulated with different breast and thigh muscles percentages. Immediately after production, chicken meat patties were analyzed for protein, fat, moisture and ash contents as well as for shear force. Moreover, patties were stored at 4°C and examined at 0,1,3,5 and 7 days of storage for pH, TBARS, cooking yield, moisture retention, color parameters and sensory properties. Whey protein concentrate incorporated treatments were higher in protein and fat content but lower in moisture and ash content. Treatments formulated with 25% breast /75% thigh were significantly higher in fat content. Inclusion of whey protein concentrate significantly decrease shear force. Cooking yield and moisture retention were significantly increased due to whey protein concentrate addition and during cold storage period. Whey protein concentrate was effective in reducing pH and TBARS-value. Treatments with added whey protein concentrate were lower in TBARS-value throughout cold storage period. L* value (lightness) and b* value (yellowness) were significantly increased during storage in whey protein concentrate treated samples, however a* value (redness) tends to decrease. Whey protein concentrate was sufficiently improved flavor, tenderness, juiciness and overall acceptability scores at the end of storage period.

INTRODUCTION

Poultry meat products are highly desirable, palatable, digestible and nutritious for all ages. In addition, they are low in price in comparison to beef and mutton. Further processing of poultry meat involves conversion of raw poultry carcasses into value added products, e.g., cold cuts, reconstructed products, or breaded products. Advantages of further processing of poultry meat are improving juiciness, flavor, shelf life and water holding capacity (**Sahoo et al., 1996**).

Comminuted meat products are complex systems in which salt-extractable muscle proteins form heat-induced gels that bind fat and water while providing texture to the product (Beuschel et al., 1992). The meat industry, like other sectors of the food industry, is searching for ingredients to improve the textural properties and moisture retention of ground and/or chopped products. As moisture is lost during cooking, product yield and other quality attributes such as flavor, tenderness and texture can be negatively affected (Offer et al., 1984; Tsai et al. 1998).

Today, many ground, formed, and whole muscle meat products rely on

various additives to enhance the texture and water binding properties, in a cost-effective manner. Non-meat proteins are added to improve water binding, stabilize fat, and control cost (Hsu and Sun, 2006; Andrès et al. 2006); however, their functionality can differ greatly. Whey and soy proteins are examples of common non-meat additives used by the meat industry.

Whey protein, a by-product of cheese manufacture, is a heterogeneous mixture of non casein milk proteins which provides an edible source of protein and is relatively cheap compared with other binders and extenders (Mittal and Usborne, 1985). They have been used in a variety of meat products including meat balls (Chen and Ocherman, 1995), beef patties (Thompson, 1982; El-Magoli et al., 1995, 1996). Whey protein concentrates can contain anywhere from 34 to 80% protein, from0 to 60% lactose, various minerals in different concentrations and ionic states, and differing levels of fat. They reduce cost of production while adding functionality and nutritive value. Whey protein concentrate has been found to function as a flavor enhancer in some meat products due to the presence of lactose (Van den Hoven, 1987). Apparently, the lactose in whey powder functions to mask bitter aftertastes produced by salts and phosphates and acts as a reducing as well as stabilizing agent.

Lipid oxidation is one of the main limiting factors for the quality and acceptability of meat and meat products. This process lead to drip loss, off-odor and off-flavor development, and the production of potentially toxic compounds (Bekhit et al., 2003; McCarthy et al., 2001a&b; Peña-Ramos andXiong, 2003). Natural antioxidants are of main interest nowadays. Synthetic antioxidants were widely used in the meat industry but consumers concern over their safety and toxicity pressed the food industry to find natural sources of antioxidant (Jadhav et al. 1996; Monahan and Troy, 1997).Whey is currently being investigated for its antioxidant activity as it contains heat stable antioxidant compounds (Browdyand and Harris, 1997; Colbert and Decker, 1991). Whey protein concentrate showed a higher efficacy as antioxidant in cooked pork patties compared to soy protein isolate, vitamin E, BHA/BHT, rosemary, and ginseng, and only tea catechins showed a better oxidation inhibition (McCarthy et al., 2001a). Therefore, the objective of this study was to evaluate the effectiveness of whey protein concentrate addition on some chemical and sensory properties of chicken meat patties formulated with different levels of light and dark meat and stored at 4°C.

MATERIALS AND METHODS

Experimental design

The study was designed to study the effect of incorporation of whey protein concentrate (80%) protein on the quality attributes of chicken meat patties formulated with different percentages of breast and thigh muscles (75% breast/25% thigh, 25% breast/75% thigh and 50% breast /50% thigh).

Raw chicken meat preparation

Fresh, boneless, skinless chicken breast and thigh meat obtained from local poultry processing plant immediately after slaughter and preparation was trimmed of all visible fat , connective tissue and stored at -20°C for up to 4 weeks prior to use. Both breast and thigh meat were tempered and ground separately in a16 mm grinder plate using Fama (Fabbrica Attrezzature Macchine Alimentrac, Rimini-Italy) meat mincer.

Production of chicken patties

For production of control formulations, frozen minced poultry meat combinations (75 breast/ 25 thigh, 25 breast/ 75 thigh and 50 thigh /50 thigh) was firstly transferred to a paddle mixer, where 1.7% common salt, 0.03% sodium polyphosphates, and 0.4%

seasonings(white pepper, cardamom, bay leaf and lemon juice) were slowly added. The batter was manually formed into discs of 50 grams using manual former (Fac Affecttatrici).For the second and the third formulations whey protein concentrate (CP International 800 E-Palge Ave Tulare cu USA) was added to at a level of 2 and 4% respectively.

Patties were placed between inter-leafing discs and sealed in plastic bags, stored at 4°C and immediately after production and then after 1,3,5 and 7 days of storage. At each sampling day patties were subjected to the following examinations.

Proximate analysis

Moisture, fat, protein and ash percentages were determined following the procedures of AOAC (1995).

Oxidative stability

Thiobarbituric acid-reactive substances (TBARS) were determined according to the method of Du and Ahn (2002).Five grams from each sample at each examination day were homogenized with 15 ml of deionized distilled water. One milliliter of the chicken meat homogenate was transferred to a test tube containing 50 µL of butylated hydroxytoluene (7.5%) and 2 ml of thiobarbituric acid (TBA)-trichloroacetic acid (TCA) (15 mM TBA-15% TCA) were added. The mixture was vortexed and then incubated in a boiling water bath for 15 min to develop colour .Then sample was cooled in cold water bath for 10 min, vortexed again, and centrifuged for 15 min at 2500 x g. The absorbance of the resulting supernatant solution was determined at 531 nm against a blank containing 1 ml of deionized water and 2 ml of TBA-TCA solution. The amounts of TBARS were expressed as mg of malonaldehyde per Kg of the product.

pH measurement

At each sampling time ten grams of each sample were homogenized with 90 ml deionized water for 2 minutes and the pH was measured using Lovibond Senso Direct pH meter with a probe type electrode (Senso Direct Type 330), where 3 readings were obtained and the mean was recorded (Allen et al., 1997).

Color evaluation

Color was determined on three raw chicken meat patties per formulation using a Minolta Chroma Meter CR410 (Minolta Co. Ltd., Japan) calibrated with a white plate and light trap. Color was expressed according to the Commission International de L'Eclairage (CIE),1976and reported as L*(lightness),a*(redness) and b*(yellowness).

Cooking procedures and physicochemical characteristics

Chicken meat patties were cooked in a preheated electric grill for 2.5 minutes on each side to reach to 70°C core temperature (Hypodermic probe-type thermocouple (Model HVP-2-21-V2-TG- 48-OCT-M Omega, Stanford, CT). All cooking measurements were done on three replicates per treatment.

Physicochemical characteristics

Cooking yield

Cooking yield of chicken patties was determined by the difference in weight before and after cooking (Piñero et al., 2008) as follows

Moisture retention

$$\text{Cooking yield \%} = \frac{\text{Cooked weight}}{\text{Raw weight}} \times 100$$

The moisture retention value represents the amount of moisture retained in the cooked product/ 100g sample. The percentage of moisture retention was calculated according to the equation of El-Magoli et al. (1996) as follows

$$\text{Moisture retention \%} = \frac{\text{Cooking yield X Moisture \% in cooked sample}}{100}$$

Sensory analysis

Sensory analysis was performed by a 9 panelists from the Department of Food Hygiene and Control, Faculty of Veterinary Medicine, Cairo University, where burger was subjected to sensory evaluation of texture, juiciness, flavor and overall acceptability. An eight point scale was used where, 8=extremely tender, juicy, intense flavor, acceptable and 1=extremely tough, dry, devoid of flavor, unacceptable. Water and bread served for cleaning the mouth between samples. Prior to the analysis panelists were trained in the definition and intensities of the investigated parameters.

Shear force

Samples were tempered to 25^{0}C for 1hour, cut into cross sections(1cm×1cm) and sheared using Instron Universal Testing Machine (model 2519-105,USA) at a crosshead speed of 200 mm/min. Mean values for samples (n=10) were expressed in terms of peak force (kg/f).

Statistical analysis

Data were subjected to analysis of variance and Tukey multiple comparisons tests using SPSS statistics 17.0 for windows. Significance was determined by the Least Significant Difference test. Main effects were considered significance at $P<0.05$.

RESULTS AND DISCUSSION

Incorporation of whey protein concentrate could decrease moisture regardless the type of meat type and the level of added whey protein concentrate level ($P<0.05$). Similar results were obtained by Desmond et al. (1998) and Serdaroğlu (2006). Fat content increased significantly in treatments formulated with 25% breast meat and 75% thigh meat either with or without whey protein concentrate addition($P<0.05$).Whey protein concentrate at both levels induced an alteration in fat content. Treatments formulated with either 25%breast/75%thigh or 50%breast/50%thigh and whey protein concentrate were higher in fat content than control group($P<0.05$).

Table (1): Proximate chemical composition of chicken meat patties

Treatments		Shear force(kg/f)	Moisture%	Protein%	Fat%	Ash%
Control	$75^B/25^T$	0.8000^a	$73.02^{a,b}$	20.00^a	3.10^a	3.88^a
	25/75	0.8200^b	$71.40^{a,c}$	16.45^b	6.14^b	6.01^b
	50/50	$0.7800^{c,d}$	73.50^b	18.81^c	4.58^c	3.11^c
2%WPC	$75^B/25^T$	0.7700^c	$72.00^{a,b,d}$	22.40^d	2.90^d	2.7^d
	25/75	0.7200^e	$70.30^{c,d,e}$	18.90^c	7.91^e	2.89^e
	50/50	0.7900^{ad}	$71.26^{c,d}$	$19.20^{c,d}$	5.55^f	3.99^a
4%WPC	$75^B/25^T$	0.9200^f	$70.23^{c,f}$	22.75^d	3.94^g	3.08^c
	25/75	0.8600^g	66.33^g	$19.85^{a,d}$	8.70^h	5.12^f
	50/50	0.7300^e	$69.45^{c,f}$	20.49^a	5.10^i	4.96^f

Means with different superscripts in the same column indicate significant differences ($P< 0.05$)
B, breast meat %; T, thigh meat %
WPC, whey protein concentrate

Added whey protein concentrate formulations were significantly higher in protein content than that of control, as whey protein concentrate used had quite a high protein content (80%).Similar results were obtained by Hayes et al. (2005);ULu (2004) and Yetim et al. (2001).In contrast to this, Serdaroğlu (2006)observed lowering in protein content of meatballs due to whey powder incorporation but he explained that by the low protein content of the used whey powder. Ash content significantly decreased due to whey protein concentrate inclusion, such observation could be attributed to the increment in protein content. However, Yetim et al. (2001) and Serdaroğlu (2006) reported a slight increase in ash content due to whey powder and fluid whey incorporation.

Shear force increased in control treatments formulated with 25% breast / 75% thigh and decreased in 50% breast /50% thigh ($P<0.05$). A significant decrease in shear force was observed among both 75% breast / 25% thigh and 25% breast/75% thigh treatments when 2% whey protein concentrate was added ($P<0.05$). However only 4% whey protein concentrate could decrease shear force in samples formulated with 50% breast / 50% thigh (Table 1).Addition of whey protein concentrate resulted in an increase in shear force of pork sausage (Lyons et al. 1999), moreover addition of whey protein enriched fractions produce a firmer frankfurter (Hayes et al., 2005).

Cooking yield percentage show a significant increase in its value among samples formulated with 75% breast meat and 25% thigh meat irrespective to whey protein concentrate addition ($P<0.05$)(Table2). During cooking, water is lost by evaporation and also as a result of denaturation, which reduces the water holding ability of the muscle proteins (Sheared et. al,1999). Breast meat contains a lower amount of fat compared with thigh meat which could explain the high cooking yield in 75% breast /25% thigh formulated samples. Whey protein concentrate incorporation at 4% level could increase cooking yield among 50% breast/50 thigh samples during storage period. Whey protein contains many hydrophilic groups that are exposed upon heating and react with water thus increasing the meats water holding capacity. Upon cooling, the proteins will entrap water and prevent moisture loss (Dybling and Smith, 1991).Several studies support the effect of whey protein in reducing cooking loss of meat products (Sammel and Claus, 2003; Serdaroğlu, 2006; Peña-Ramos andXiong; 2003; Barbut, 2006; Hayes et al., 2005; Correia and Mittal, 1991; Ker and Toledo, 1992). However, ULu (2004) reported a decrement in cooking yield of cooked meatballs formulated with whey protein concentrate. Lower cook loss results indicate the product's increased ability to bind and retain water during cooking (Giese, 1992).

Moisture retention was significantly increased among the product formulated with 25% breast/75%thigh and 2% whey protein concentrate ($P<0.05$)(Table2). This result was in a good agreement with that obtained by Serdaroğlu (2006) who observed that whey protein could increase moisture retention values of meatballs. Moreover during storage period 2% whey protein concentrate could maintain this increment which can be attributed to the increased protein content and gelling ability of whey proteins (Bottomley et al .1990).

As expected pH values were significantly increased in all treatments formulated with 75% thigh meat reflecting the high pH of thigh meat ($P<0.05$). Whey protein concentrate at both levels could significantly decreased pH values at all different breast and thigh formulations ($P<0.05$). During storage there was an increment in pH value after 3 days which then tend to decrease ($P<0.05$). A slight increase in pH value was recorded by Sammel and Claus (2003) and Yetim et al. (2001) due to whey protein concentrate and fluid whey addition to cooked ground turkey breast and frankfurter-type sausage respectively. Serdaroğlu (2006) failed to detect any effect of whey powder on pH of meatballs.

Table (2): Cooking yield and moisture retention of chicken meat patties

Treatments		Day-o		Day-1		Day-3		Day-5		Day-7	
		Cooking yield	Moisture retention	Cooking yield	Moisture retention	Cooking yield	Moisture retention	Cooking yield	Moisture retention	Cooking yield	Moisture retention
Control	$75^{B}/25^{T}$	$_{i}85.30^{a}$	$_{i}54.16^{a}$	$_{ii}77.47^{a}$	$_{ii}46.56^{a}$	$_{ii,iii}75.93^{a,b}$	$_{ii}46.33^{a,b}$	$_{ii,iii}75.70^{a,b}$	$_{ii}45.57^{a,b}$	$_{iii}75.07^{a}$	$_{ii}45.37^{a}$
	25/75	$_{i}77.45^{b}$	$_{i}47.42^{b,c}$	$_{i}76.92^{a}$	$_{ii}46.43^{b}$	$_{i,ii}75.70^{a}$	$_{i}46.42^{a,d}$	$_{ii}75.01^{a,b}$	$_{i}43.38^{a}$	$_{iii}71.14^{b}$	$_{iii}41.25^{b}$
	50/50	$_{i}81.93^{c}$	$_{i}54.86^{a}$	$_{ii}77.20^{a}$	$_{ii}46.91^{a}$	$_{iii}73.11^{c}$	$_{iii}44.03^{c}$	$_{iii,iv}71.50^{c}$	$_{iii}43.56^{b,c.d}$	$_{iv}70.81^{b,d}$	$_{iii}42.88^{c,f}$
2%WPC	$75^{B}/25^{T}$	$_{i}83.67^{a}$	$_{i}54.55^{a}$	$_{ii}78.03^{a}$	$_{ii}49.02^{b,c}$	$_{ii}77.36^{b}$	$_{iii}44.14^{b,c}$	$_{ii,iii}76.28^{a}$	$_{ii,iii}43.25^{c}$	$_{iii}75.16^{a}$	$_{i,v}41.89^{d}$
	25/75	$_{i}80.29^{c}$	$_{i}48.98^{c}$	$_{ii}76.44^{a}$	$_{i}47.32^{a}$	$_{ii}75.59^{a}$	$_{i}47.61^{d,e}$	$_{iii}72.60^{c}$	$_{ii}44.14^{c}$	$_{iii}71.20^{b,d}$	$_{ii}43.47^{c,e}$
	50/50	$_{i}81.37^{c}$	$_{i}52.65^{d}$	$_{ii}77.24^{a}$	$_{ii}47.40^{c,d}$	$_{ii}76.48^{a,b}$	$_{iii}46.27^{a,e}$	$_{iii}74.44^{b}$	$_{iii}44.67^{b,c}$	$_{iii}73.18^{e}$	$_{iii}45.81^{a,e,g}$
4%WPC	$75^{B}/25^{T}$	$_{i}78.39^{b}$	$_{i}47.57^{b,c}$	$_{i,ii}76.92^{a}$	$_{ii}45.85^{d,e}$	$_{ii,iii}75.99^{a,b}$	$_{iii}44.70^{c}$	$_{iii,iv}75.04^{a,b}$	$_{iii,iv}43.31^{c}$	$_{iv}73.86^{a,e}$	$_{iv}42.63^{c,g}$
	25/75	$_{i}77.87^{b}$	$_{i}46.57^{b,c}$	$_{i,ii}76.46^{a}$	$_{ii}45.23^{f}$	$_{ii}75.71^{a,b}$	$_{i,iii}44.93^{a,b,f}$	$_{ii}75.50^{a,b}$	$_{iii,iv}43.83c$	$_{iii}70.34^{b}$	$_{iv}42.17^{b,f}$
	50/50	$_{i}76.69^{d}$	$_{i,ii}45.80^{e}$	$_{ii}75.85^{a}$	$_{iii}45.49^{e}$	$_{ii,iii}75.36^{a,b}$	$_{i,iv}45.07^{c,f}$	$_{i,iii}74.77^{a,b}$	$_{ii}43.41^{a,b,d}$	$_{i}72.43^{b,d,e}$	$_{iv}42.78^{b,c}$

* a-f: Means with different superscript within the same column differ significantly at P<0.05.
* i-v: Means with different subscript within the same row differ significantly at P<0.05.
B, breast meat %; T, thigh meat %
WPC, whey protein concentrate

Table (3): PH and TBARS-value of chicken meat patties

Treatments		Day-o		Day-1		Day-3		Day-5		Day-7	
		PH	TBARS	PH	TBARS	PH	TBARS	PH	TBARS	PH	TBARS
Control	$75^B/25^T$	$_{i,iii}6.21^a$	$_i0.16^{a,b}$	$_i6.23^{a,e,g}$	$_i0.22^a$	$_{ii}6.27^a$	$_i0.28^{a,b}$	$_{i,iii}6.22^a$	$_i0.31^a$	$_{iii}6.19^a$	$_i0.36^a$
	25/75	$_i6.47^b$	$_i0.21^c$	$_i6.44^b$	$_{ii}0.25^b$	$_i6.47^b$	$_{iii}0.29^a$	$_i6.45^b$	$_{iii}0.30^{a,b}$	$_i6.47^b$	$_{iv}0.38^b$
	50/50	$_i6.32^c$	$_i0.18^{d,e}$	$_{ii}6.36^c$	$_{ii}0.24^{b,c}$	$_{ii}6.36^c$	$_{iii}0.27^b$	$_i6.3^{a,b}$	$_{iv}0.29^b$	$_{i,ii}6.33^c$	$_v0.31^c$
2%WPC	$75^B/25^T$	$_i6.17^d$	$_i0.16^{a,b}$	$_i6.13^d$	$_{ii}0.19^d$	$_i6.22^d$	$_{ii,iii}0.20^{c,d}$	$_i6.20^a$	$_{iii}0.21^{c,f}$	$_i6.21^a$	$_{iv}0.34^d$
	25/75	$_i6.4^c$	$_i0.20^{c,f}$	$_i6.40^{b,c}$	$_{ii}0.23^{a,c}$	$_{ii}6.47^b$	$_{iii}0.27^b$	$_{i,ii}6.43^b$	$_{iv}0.29^b$	$_{ii}6.47^b$	$_v0.39^b$
	50/50	$_i6.25^f$	$_i0.17^{a,d}$	$_i6.24^c$	$_{ii}0.19^d$	$_i6.37^c$	$_{iii}0.21^c$	$_i6.40^b$	$_{iv}0.23^d$	$_i6.34^c$	$_v0.28^e$
4%WPC	$75^B/25^T$	$_i6.09^g$	$_i0.15^b$	$_i6.07^f$	$_i0.15^e$	$_{ii}6.16^e$	$_i0.16^e$	$_{ii}6.19^a$	$_{ii}0.18^e$	$_{iii}6.25^d$	$_{ii}0.19^f$
	25/75	$_i6.34^c$	$_i0.19^{e,f,g}$	$_{ii}6.28^{a,e}$	$_i0.19^d$	$_{iii}6.51^f$	$_i0.20^{c,f}$	$_{iv}6.42^b$	$_{ii}0.22^{c,d}$	$_{iv}6.42^e$	$_{iii}0.24^g$
	50/50	$_i6.22^a$	$_i0.18^{d,g}$	$_{ii}6.18^{d,g}$	$_i0.18^d$	$_{iii}6.37^c$	$_{i,ii}0.19^{d,f}$	$_{iv}6.33^{a,b}$	$_{ii}0.20^f$	$_{iii}6.38^f$	$_{iii}0.22^h$

* a-f: Means with different superscript within the same column differ significantly at $P<0.05$.
* i-v: Means with different subscript within the same row differ significantly at $P<0.05$.

B, breast meat %; T, thigh meat %

WPC, whey protein concentrate

Table (4): Color parameters of raw chicken meat patties

Treatments		D-0			Day-1			Day-3			Day-5			Day-7		
		L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*
Control	$75^B/25^T$	$_{i}56.40^{a}$	$_{i}11.66^{a,b}$	i14.59a	ii53.72a	ii10.73a	i14.67a	$_{iii}52.61^{a}$	iii9.45a	i14.72^{a}	$_{iv}52.14^{a}$	$_{iv}8.99^{a,b}$	$_{i,ii}14.34^{a,b}$	$_{v}50.72^{a}$	$_{v}6.77^{a}$	$_{ii}13.75^{a}$
	25/75	$_{i}56.06^{b}$	$_{i}13.05^{c}$	$_{i}16.73^{b}$	$_{ii}54.06^{a}$	$_{ii}11.5^{b}$	$_{ii}15.97^{b}$	$_{iii}53.50^{b}$	$_{iii}9.88^{b}$	$_{iii}15.44^{a}$	$_{iv}52.44^{a,b}$	$_{iv}9.34c$	$_{iv}14.34^{a,b}$	$_{iii}52.39^{b,c}$	$_{v}5.71^{b}$	$_{v}13.73^{a}$
	50/50	$_{i}56.26c$	$_{i}12.42^{d}$	$_{i}16.75^{b}$	$_{ii}53.49^{a}$	$_{ii}11.15^{c}$	$_{ii}15.24c$	$_{ii}53.47^{b}$	$_{iii}10.12^{c}$	$_{iii}14.40^{b}$	$_{iii}52.70^{b,c}$	$_{iv}8.93b,^{d}$	$_{iv}14.38^{a,b}$	$_{ii}52.20^{b}$	$_{v}6.01c$	$_{v}14.34^{b}$
2%WPC	$75^B/25^T$	$_{i}58.42^{d}$	$_{i}11.14^{e}$	$_{i}17.97^{c}$	$_{ii}54.57^{b}$	$_{ii}9.06^{d}$	$_{ii}16.24^{b,d}$	$_{iii}52.86^{a}$	$_{iii}7.86^{d}$	$_{ii}16.48^{c}$	$_{iii,iv}52.50a,c$	$_{iv}7.12e$	$_{iii}15.77^{c}$	$_{v}52.00^{d}$	$_{v}7.33^{d}$	$_{iii}15.60^{c}$
	25/75	$_{i}59.10^{c}$	$_{i}11.53^{b,f}$	$_{i}16.09^{b,d}$	$_{ii}56.38^{c}$	$_{ii}11.15^{c}$	$_{i}16.34^{d,e}$	$_{iii}54.35^{c}$	$_{iii}9.40^{a}$	$_{ii}15.07^{a}$	$_{iii}54.25^{d,e}$	$_{iv}8.73^{d}$	$_{ii}14.65^{b,d}$	$_{iv}53.97^{b,e}$	$_{v}7.21^{d,e}$	$_{ii}14.58^{b}$
	50/50	$_{i}58.25^{f}$	$_{i}11.64^{a,b}$	$_{i}16.35^{b,c}$	$_{ii}55.97^{b}$	$_{ii}10.67^{a}$	$_{ii}14.93^{a}$	$_{iii}54.72c$	$_{iii}8.93e$	$_{ii}14.70a$	$_{iv}54.02d$	$_{iv}7.40f$	$_{iii}13.85c$	$_{v}51.81d$	$_{v}6.93^{a,f}$	$_{iii}13.49^{a}$
4%WPC	$75^B/25^T$	$_{i}57.69^{e}$	$_{i}9.62^{g}$	$_{i}15.67^{a,f}$	$_{ii}56.51^{d}$	$_{ii}8.58^{e}$	$_{ii}15.42^{a}$	$_{iii}54.54^{c}$	$_{iii}8.17^{f}$	$_{iii}15.41^{c}$	$_{iii}54.33^{d,e}$	$_{iv}6.37^{g}$	$_{i,ii}15.13^{d,f}$	$_{iv}53.69^{b,c}$	$_{v}5.44^{g}$	$_{i}15.04^{c}$
	25/75	$_{i}57.64^{g}$	$_{i}11.81^{a}$	$_{i}16.06^{d,e,f}$	$_{ii}55.62^{d}$	$_{ii}11.31^{b,c}$	$_{i}15.72^{b,c}$	$_{iii}54.42c$	$_{iii}10.06^{b,c}$	$_{ii}15.00a$	$_{iii}54.20^{d}$	$_{iv}9.17^{a,c}$	$_{ii}14.69^{b,f}$	$_{iii}53.87^{b,c}$	$_{v}7.03^{e,f}$	$_{ii}14.59^{b}$
	50/50	$_{i}57.53^{h}$	$_{i}10.29^{h}$	$_{i}15.74^{d,e,f}$	$_{ii,iii}55.21^{d}$	$_{i}10.25^{f}$	$_{i}15.99^{b}$	$_{ii}55.57^{d}$	$_{ii}7.61^{g}$	$_{i}15.26^{a}$	$_{iii,iv}54.61^{e}$	$_{iii}6.69^{h}$	$_{ii}14.24^{a,e}$	$_{iv}54.18^{c,e}$	$_{iv}5.41^{g}$	$_{ii}13.85^{a}$

* a-f: Means with different superscript within the same column differ significantly at P<0.05.

* i-v: Means with different subscript within the same row differ significantly at P<0.05.

B, breast meat %; T, thigh meat %

WPC, whey protein concentrate

Table (5): Sensory evaluation of cooked chicken meat patties

Treatments		D-0				Day-1				Day-3				Day-5				Day-7			
		F	T	J	O	F	T	J	O	F	T	J	O	F	T	J	O	F	T	J	O
Control	$75^{B}/25^{T}$	$_{i}6.66^{a}$	$_{i}6.66^{a}$	$_{i}6.50^{a}$	$_{i}6.83^{a}$	$_{ii}6.66^{a}$	$_{i,ii}6.00^{a}$	$_{i}6.33^{a}$	$_{i}7.00^{a}$	$_{i}6.33^{a}$	$_{i,ii}5.33^{a}$	$_{i}5.33^{a,b,c}$	$_{i}7.00^{a,b,c}$	$_{i}6.00^{a}$	$_{i,ii}5.83^{a,b}$	$_{i}5.66^{a,b,c}$	$_{i}6.00^{a}$	$_{ii}3.00^{a}$	$_{ii}4.00^{a}$	$_{i}3.00^{a}$	$_{ii}4.00^{a}$
	25/75	$_{i,ii}6.66^{a}$	$_{i}6.00^{a}$	$_{i}6.33^{a}$	$_{i}6.66^{a}$	$_{i,ii}5.66^{a}$	$_{i,ii}6.00^{a}$	$_{i}5.50^{a}$	$_{i}6.66^{a}$	$_{i}6.00^{a}$	$_{i}5.00^{a}$	$_{i}6.33^{a,b,c}$	$_{i}6.66^{a,b,c}$	$_{i,ii}5.66^{a}$	$_{i}4.66^{a,b}$	$_{i}6.33^{b}$	$_{i}6.50^{b,c}$	$_{ii}4.00^{a}$	$_{ii}2.00^{a}$	$_{ii}2.00^{a}$	$_{ii}3.00^{a}$
	50/50	$_{i}6.66^{a}$	$_{i}7.33^{a}$	$_{i}7.33^{a}$	$_{i}7.00^{a}$	$_{i}6.00^{a}$	$_{i,ii}6.66^{a}$	$_{i}6.16^{a}$	$_{i,ii}7.00^{a}$	$_{i}6.00^{a}$	$_{i,ii}6.33^{a}$	$_{i}6.16^{a,b,c}$	$_{i}7.00^{a,b,c}$	$_{i}6.00^{a}$	$_{i,ii}6.00^{a,b}$	$_{i}6.16^{a,b,c}$	$_{i}6.00^{a,c}$	$_{i}5.00^{a}$	$_{ii}4.00^{a}$	$_{ii}3.00^{a}$	$_{ii}5.00^{a}$
2%WPC	$75^{B}/25^{T}$	$_{i}6.00^{a}$	$_{i}6.00^{a}$	$_{i}5.66^{a}$	$_{i}6.66^{a}$	$_{i}5.33^{a}$	$_{i}5.33^{a}$	$_{i}5.33^{a}$	$_{i}6.33^{a}$	$_{i}5.33^{a}$	$_{i}5.00^{a}$	$_{i}5.00^{a,b,c}$	$_{i}6.33^{a,b,c}$	$_{i}5.00^{a}$	$_{i}4.66^{a}$	$_{i}4.66^{c}$	$_{i}6.33^{a,c}$	$_{i}4.00^{a}$	$_{i}4.00^{a}$	$_{i}4.00^{a}$	$_{i}6.00^{a}$
	25/75	$_{i}7.00^{a}$	$_{i}7.00^{a}$	$_{i}7.33^{a}$	$_{i}7.33^{a}$	$_{i}6.66^{a}$	$_{i}7.00^{a}$	$_{i}6.66^{a}$	$_{i}7.33^{a}$	$_{i}6.66^{a}$	$_{i}6.83^{a}$	$_{i}6.50^{b}$	$_{i}7.00^{b}$	$_{i}6.33^{a}$	$_{i}6.83^{a,b}$	$_{i}6.33^{a,b,c}$	$_{i}7.66^{c}$	$_{ii}3.00^{a}$	$_{ii}3.00^{a}$	$_{i}4.00^{a}$	$_{i}6.00^{a}$
	50/50	$_{i}6.66^{a}$	$_{i}6.33^{a}$	$_{i}7.16^{a}$	$_{i}7.33^{a}$	$_{i,ii}6.00^{a}$	$_{i}6.33^{a}$	$_{i}6.66^{a}$	$_{i,ii}7.33^{a}$	$_{i}6.00^{a}$	$_{i}6.33^{a}$	$_{i}6.66^{a,b}$	$_{i}6.33^{a,b}$	$_{i}6.00^{a}$	$_{i}6.00^{a,b}$	$_{i}5.83^{a,b,c}$	$_{i,ii}6.33^{a,c}$	$_{ii}4.00^{a}$	$_{i}6.00^{a}$	$_{i}5.00^{a}$	$_{ii}5.00^{a}$
4%WPC	$75^{B}/25^{T}$	$_{i}6.33^{a}$	$_{i}5.66^{a}$	$_{i}5.33^{a}$	$_{i}6.50^{a}$	$_{i}6.33^{a}$	$_{i}5.66^{a}$	$_{i}5.33^{a}$	$_{i}6.50^{a}$	$_{i}6.33^{a}$	$_{i}5.44^{a}$	$_{i}5.33^{c}$	$_{i}6.33^{c}$	$_{i}6.00^{a}$	$_{i}5.33^{a}$	$_{i}6.33^{a,b,c}$	$_{i}6.33^{a,c}$	$_{i}6.00_{a}$	$_{i}5.00^{a}$	$_{i}6.00^{a}$	$_{i}6.00^{a}$
	25/75	$_{i}7.00^{a}$	$_{i}7.33^{a}$	$_{i}6.66^{a}$	$_{i}7.00^{a}$	$_{i}7.00^{a}$	$_{i}6.66^{a}$	$_{i}6.66^{a}$	$_{i}7.00^{a}$	$_{i}6.66^{a}$	$_{i}6.00^{a}$	$_{i}6.33^{a,b,c}$	$_{i}7.00^{a,b,c}$	$_{i}6.66^{a}$	$_{i}6.00^{a}$	$_{i}6.33^{a,b}$	$_{i}7.00^{a,c}$	$_{i}6.00^{a}$	$_{i}6.00^{a}$	$_{i}5.00^{a}$	$_{i}7.00^{a}$
	50/50	$_{i}6.66^{a}$	$_{i}6.00^{a}$	$_{i}5.66^{a}$	$_{i}6.33^{a}$	$_{i}6.66^{a}$	$_{i}6.00^{a}$	$_{i}5.66^{a}$	$_{i}6.33^{a}$	$_{i}6.66^{a}$	$_{i}6.00^{a}$	$_{i}5.50^{a,b,c}$	$_{i}6.33^{a,b,c}$	$_{i}6.33^{a}$	$_{i}6.00^{a}$	$_{i}5.16^{a,b}$	$_{i}6.33^{a,c}$	$_{i}6.00^{a}$	$_{i}5.41^{a}$	$_{i}5.00^{a}$	$_{i}6.00^{a}$

F, flavor- T, tenderness-J, juiciness-O, overall acceptability

* a-f: Means with different superscript within the same column differ significantly at $P<0.05$.

* i-v: Means with different subscript within the same row differ significantly at $P<0.05$.

B, breast meat %; T, thigh meat %

WPC, whey protein concentrate

Formulations incorporated with whey protein concentrate were significantly lower in TBAR-S value than that without added whey protein concentrate (P<0.05) (Table 3). During refrigerated storage whey protein concentrate was able to decrease TBARS-value at all formulations regardless its concentration (P<0.05). Whey protein concentrate usually contains higher concentrations of other components, such as lactose which upon cooking, could lead to the formation of antioxidative Maillard components. These Maillard reaction products would conceivable enhance the antioxidative potential of whey protein concentrate (MacCarthy et al., 2001b).Similarly several studies observed the antioxidative stability of meat products incorporated with whey. Coronado et al. (2002) observed a slower rate of oxidation in wiener sausages with added whey powder. Whey protein isolate and its hydrolytic product at 2% application level was able to suppress lipid oxidation in cooked pork patties during refrigerated storage (Peña-Ramos and Xiong , 2003), also whey protein concentrate could suppress lipid oxidation in cooked meatballs during storage period (Ulu, 2004).

It is clearly evident that all color values significantly decreased throughout storage period in all treatments regardless whey protein concentrate addition (P<0.05)(Table 4). Addition of 2% whey protein concentrate addition could increase L* value in all different meat type formulations compared with control group, but after 3 days of storage 4% whey protein concentrate could significantly increase L* value till the end of storage period (P<0.05). At the 7th day of storage b* value was significantly increased either by 2% or 4%. Whey protein concentrate addition incorporation among treatments formulated with 75% breast / 25% thigh and 25% breast / 75% thigh. However, in 50% breast /50% thigh samples b* value decreased (P<0.05). Whey protein concentrate decreased a* value in all formulations (P<0.05). Results of instrumental color were in good agreement with several studies concerned with using of whey protein (Hung and Zayas, 1992; Atughonu et al., 1998; Hughes et. al., 1998; Sammel and Claus,2003;Ulu, 2004;Hayes et al., 2005). However Serdaroğlu (2006) concluded that whey protein level significantly affected L* value of cooked meatballs but had no effect on a* and b* value..

Whey protein concentrate was significantly improved flavor score at the end of storage period when incorporated at 4%. Similarly, Holland (1984) recorded an increase in flavor scores of comminuted beef patties duo to whey protein addition. Marriot et al. (1998) reported that boneless hams containing liquid whey did not have any whey flavor. However, tenderness, juiciness and overall acceptability scores were increased at the end of storage period as a result of whey protein concentrate addition irrespective to its level. Panelists were not able to detect the addition of whey concentrate protein and had no criticism of the product. It was reported that products made with whey proteins have been found to be of high organoleptic quality (Mann, 1989), this supports findings of Hayes et al. (2005) who concluded that some whey protein-enriched fractions could improve

tenderness of frankfurters. Moreover, Ensor et al. (1987) reported that knockwurst with whey protein was juicier than the controls. In contrast to this, it was reported that whey protein played no effect on any of the sensory characteristics of the frankfurters (Murphy et al., Hughes et al., 1998; Yetim et al 1996. 2001).Also whey protein addition had no effect on texture, flavor, or overall acceptability of wieners (Thompson et al., 1982).

It could be concluded that incorporation of whey protein concentrate increased protein content and decreased shear force of chicken meat patties formulated with different breast and thigh muscles combinations during storage. Whey protein concentrate significantly increased cooking yield and moisture retention; it was effective in reducing pH and TBARs values. It addition was sufficient to improve colour parameters and sensory attributes at the end of chilling storage period.

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تأثير اضافة مركز بروتين شرش اللبن علي جودة عجائن لحم الدواجن أثناء تخزينها عند درجة٤ درجة مئوية

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في هذة الدراسة تمت إضافة مركز بروتين شرش اللبن بنسبة ٢و٤% إلى عجائن لحم الدجاج المصنعة بنسب مختلفة من لحوم الصدر والفخذ وبعد تمام عملية التصنيع فحصت هذه العجائن من حيث محتوى البروتين، الدهن، الرطوبة والرماد وأيضاً لقيمة قوة الشد.وبعد ذلك تم تخزينها عند درجة حرارة ٤م°وفحصها عند أول يوم من التصنيع ثم بعد ١ ، ٣ ، ٥ ، ٧ أيام من التخزين من حيث درجة تركيز أيون الهيدروجين، قيمة حامض الثيوباربيتيوريك، نسبة ناتج الطهي، نسبة الاحتفاظ بالرطوبة، مقاييس اللون وأخيراً الخصائص الحسية. وقد أظهرت النتائج أن المعاملات التي تحتوي على مركز بروتين شرش اللبن كانت الأعلى من حيث محتوى البروتين والدهن والأقل في محتواها للرطوبة والرماد، وكانت نسبة الدهن في المعاملات التي تم تصنيعها من ٢٥% لحوم الصدر و ٧٥% لحوم الفخذ أعلى معنوياً من المعاملات الأخرى. أيضاً أدت إضافة مزكز بروتين شرش اللبن إلى حدوث نقص معنوي في قيمة قوة الشد. في حين أن نتائج نسبة الاحتفاظ بالرطوبة وناتج الطهي تشير إلى الزيادة المعنوية نتيجة لإضافة مركز بروتين شرش اللبن وذلك اثناء فترة التخزين في حين أن قيمة درجة تركيز أيون الهيدروجين وقيمة حامض الثيوباربيتيوريك أظهرت نقصاً معنوياً. أدت إضافة مركز بروتين شرش اللبن إلى الزيادة المعنوية في مقاييس اللون والتحسن في الخصائص الحسية ودرجة القبول العام للمعاملات في نهاية فترة التخزين.