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Chemical Composition and Quality Characteristics of Emulsion Type Turkey Rolls Formulated with Dairy Ingredients

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Abstract: Effects of 3%sodium caseinate(SC), 3% milk powder (MP), 3% whey powder (WP), and mixture of 1%SC+1%MP+1%WPC (MIX) on quality characteristics of emulsion type turkey rolls were investigated. Addition of dairy ingredients significantly increased water holding capacity and emulsion stability. Rolls added dairy ingredients had lower cooking losses than control. Adding SC and MIX increased lightness of turkey rolls bu did not affect redness. Rolls with WP and MIX had lower shear force values. Mixture of dairy ingredients gave better sensory scores.

Key words: Sodium caseinate, milk powder, whey protein, turkey roll, meat emulsions

Introduction

Comminuted meat products are complex food systems in which water absorption, gelation and emulsion formation influence stability and texture of cooked product (Ellekjaer *et al.*, 1996). Using non-meat proteins in meat products decreases costs and increases product yield. Dairy ingredients have been used as fillers and binders in comminuted meat products to improve not only emulsifying capacity but also emulsion stability, immobilization of water to improve texture and sensory properties. Dairy ingredients can be utilized to improve the flavor, texture, appearance and nutritional value of comminuted meat products, as well as providing a greater flexibility of formulation to minimize processing losses. Such ingredients are especially useful for cases of limited salt-soluble myofibrillar protein in low meat or cheap meat products (Hung and Zayas, 1992).

Skim-milk powder is widely used as neutral filler with good water binding effect in comminuted meat products, but lactose may cause discoloration of meat products because of Maillard reactions with proteins (Ellekjær *et al.*, 1996). Various caseinates have also been used in meat emulsion products. Sodium caseinate contains about 90% protein and is completely soluble in water and is an ideal emulsifier with a strong effect on fat/water or air/water interfaces. It emulsifies free fat and forms stable emulsions (El-Magoli *et al.*, 1996). Sodium caseinate indirectly contributes to water retention and texture of an emulsion, but gelation upon heating is lacking (Baardseth *et al.*, 1992).

El-Magoli *et al.*, (1996) concluded that whey protein concentrate may be effectively used as a functional ingredient in low-fat beef burgers due to its heat gelation and emulsification properties. The effect of different non-meat proteins on quality of meat products has been investigated. But most of the research focused on products formulated with beef (El-Magoli *et al.*, 1996; Ellekjær *et al.*, 1996; Desmond *et al.*, 1998; Troy and Buckley, 1996; Yetim *et al.*, 2001 and Serdaroðlu and Sapancý, 2003) and pork (Hung and Zayas, 1992; Hughes *et al.*, 1998; Lyons *et al.*, 1999 and Troy *et al.*, 1999), no research has been done on using dairy ingredients in emulsion type turkey products.

Our objective was to study the effects of using 3% skim milk powder (MP), 3%sodium caseinate (SC), 3% whey powder (WP) and a mixture of 1% MP + 1% SC+ 1% WP (MIX) on chemical composition, technological and sensory quality of emulsion type turkey rolls.

Materials and Methods

Material: Five different roll formulations (Table 1) were prepared in two seperate trials. Fresh lean turkey meat (50% breast + 50% thigh) and skin were obtained from local meat processing plant. All visible fat and connective tissue were trimmed of and meats were ground through a 3 mm plate using meat grinder. The average pH of turkey mince was 5.86, the protein content was 20.1 %, the moisture content was 74.5 % and the fat content was 2.9 %. Four products were prepared containing 3% sodium caseinate (SC) (85 % protein DMW Co. Netherland) , 3% milk powder (MP) (40 % protein, Pýnar Dairy Co.) , whey powder (WP) (13 % protein, de mineralized Pýnar Dairy Co.) or dairy mix (MIX) (1%SC+ 1%MP+1%WP). Control batch (C) without dairy ingredient was also prepared to give a total of 5 treatments. The ground lean turkey meat, skin, dairy ingredient, salt, spices mixture, nitrite salt, sodium ascorbate and water chopped for 10 min in a bowl chopper. The batters were than stuffed into 15 mm cellulose casings and cooked in boiling water to 80°C internally and cooled before slicing.

Table1: Formulations for turkey rolls with various dairy ingredients

Treatment	Meat	Skin	Dairy ingredient	Ice	Salt	NS[a]	Na A[b]	Spice[C]
C[d]	62.47	13.15	0	21.69	1.5	0.05	0.05	1.5
SC	50.14	14.97	3	29.18	1.5	0.05	0.05	1.5
MP	50.11	13.49	3	30.69	1.5	0.05	0.05	1.5
WP	50.11	13.46	3	30.72	1.5	0.05	0.05	1.5
(MIX) SC+MP+WP	50.12	13.52	3	30.42	1.5	0.05	0.05	1.5

[a] Nitrite salt, [b] sodium ascorbate, [c] spice mix, [d] no added

Measurements: For each batter and product, pH (AOAC,1990), moisture (AOAC), fat (Flyn and Bramblet, 1976) and protein (Anon,1979) were determined. Water holding capacity (WHC) of batter was determined according to Lianji and Chan (1991), 10 g sample was placed in glass jar and heated at 90°C for 10 min in water bath. . After heating, the sample was removed, cooled to room temperature, wrapped in a cotton cheesecloth, and centrifuged in 10 ml polycarbonate tubes (containing absorbent cotton wool) centrifuged for ten min at 10.000 rpm, the cheesecloth was removed and the sample weight was recorded. The following equation was used to calculate WHC:

$$\%WHC = 1\text{-}T/M \times 100 = 1\text{-}B\text{-}A/M \times 100$$

T = Total fluid loss during heating and centrifugation
M = Total water content in the sample
B = Weight of sample before heating
A = weight of sample after heating and centrifugation

Emulsion stability was measured using the procedure of Hughes *et al.* (1997). Approximately 25 g (exact weight recorded) of the raw emulsion was placed in a centrifuge tube and centrifuged for 2 min at 4000 rpm then heated in a water bath for 30 min at 70°C and then centrifuged again for 3 min at 4000 rpm. The pellet was removed and weighed and the supernatant was poured into pre-weighed crucibles and dried overnight at 100°C. The volume **of total expressible fluid (TEF) and the percentage fat was calculated as follows:**

TEF = (Weight of centrifuge tube and sample) - (Weight of centrifuge tube and pellet)

%TEF = TEF/ sample weight × 100,

% Fat = (Weight of crucible + dried supernatant) − (Weight of empty crucible) / TEF × 100

The weights of rolls before and after cooking were recorded and the cooking loss was expressed as a percentage difference between the raw and cooked weights (Hughes *et al.*, 1997). CIE color values (L*, a*, b*) of the cooked turkey roll were determined by Minolta 508d spectrophotometer. Slices approximately 10mm thick were immediately were placed on thin glass plate and L*, a* and b* values were obtain within 10 s. Readings were taken on 6 slices per roll.

Shear force analysis was performed on the Instron Universal Testing Machine (Model 1140). Shear force, as peak force was determined by shearing a 2.5 cm height and 2 cm diameter core sample with a Warner Bratzler blade mounted in the Instron. 10 kg load cell was used at a speed of 100 mm/ min. Shear force (kg) was expressed maximum force to shear the sample. Data were recorded as the average of 6 samples per treatment.

A seven-member trained panel conducted sensory evaluation. The panelists were chosen on the basis of previous experience in evaluating rolls. The following attributes were evaluated on a 7-point scale: appearance, flavor and texture. The trial was performed twice and the data was evaluated by two-way analysis of variance (ANOVA). Significance of differences was defined as ($P<0.05$).

Results and Discussion

Mean percent moisture, protein, fat, ash and pH values of raw (roll batter) and cooked turkey rolls were given in Table 2. **Uncooked turkey rolls had a moisture content ranging from 75.3 to 73.3%, fat content ranging from 7.6-**8.7% and protein content varied between 16.2 to 12.0%. Rolls with WP had lower protein content than other samples. This lower protein content was due to the lower quantity of protein (13%) in WP. No differences were found in other chemical constitutents of raw turkey roll. Using dairy ingredients slightly increased batter pH. Adding SC resulted higher batter pH, the high pH value was due to the greater quantity of protein in SC and it led to increase in nitrogen level of raw batter. As a result of cooking there was a clearly increase in fat and protein contents, this increment in fat and protein content is a result of cooking loss. Dairy ingredients significantly affected moisture content of cooked rolls, control sample had lowest moisture content (68.7%). A slight variation was dedected in proximate composition of cooked rolls as expected, the protein and fat levels of rolls varied

Table 2: Proximate composition and pH values of roll batter and cooked turkey roll

Treatment	Raw Moisture	Roll (Batter) Fat	Protein	Ash	pH
C	74.2±0.23	7.8±0.74	16.2^{a}±0.53	1.9±0.02	5.9^{b}±0.02
SC	73.8±0.88	8.6±0.87	15.8^{a}±0.34	1.9±0.08	6.3^{a}±0.03
MP	75.3±0.28	7.6±0.11	13.8^{b}±1.01	1.9±0.03	6.1^{b}±0.9
WP	74.8±0.92	8.0±1.23	12.0^{c}±1.03	1.7±0.01	6.1^{b}±0.04
MIX	73.3±0.88	8.7±0.92	14.2^{b}±0.87	1.5±0.06	6.2^{b}± 0.07
Treatmen	Moisture	Cooked Fat	Roll Protein	Ash	PH
C	68.7^{b}±1.09^{A}	9.7±1.65	19^{a}.0±0.98	1.2±0.98	6.0^{b}±0.01
SC	71.0^{a}±1.07	9.1±0.98	16.1^{b}±1.23	1.8±0.74	6.3^{a}±0.06
MP	71.3^{a}±0.54	9.4±0.34	16.8^{b}±1.09	1.8±0.65	6.0^{b}±0.9
WP	70.8^{a}±0.76	11.1±1.11	17.7^{b}±0.43	1.7±0.43	6.1^{b}±0.04
MIX	71.6^{a}±0.33	10.2±0.67	16.9^{b}±0.87	1.5±0.46	6.2^{a}±0.02

[A] Standart deviation, C: Control, SC: sodium caseinate, MP: milk powder, WP: whey powder, MIX: SC+MP+WP. Different levels in the same column indicate significant differences ($p<0.05$)

Table3: Influence of dairy ingredients on roll batter characteristics

Treatment	WHC%	Emulsion stability TEF%	Fat%	Cooking Loss %
C	37.8^{c}±1.54^{A}	27.3^{a}±0.86	7.0^{b}±1.34	23.5^{a}±0.54
SC	65.2^{a}±1.23	16.0^{c}±0.34	6.0^{ba}±1.09	16.7^{b}±0.33
MP	52.7^{b}±0.98	16.2^{c}±0.23	6.9^{b}±1.98	12.4^{c}±0.54
WP	44.6^{c}±0.23	20.9^{b}±0.92	8.2^{a}±0.34	16.8^{b}±0.11
MIX	53.4^{b} ±0.54	18.2^{b}±0.33	7.8^{a}±0.45	17.2^{b}±1.23

[A] Standart deviation Different levels in the same column indicate significant differences ($p<0.05$)

Table 4: Color (L*,a*,b*) and shear force values of Turkey rolls

Additives[1]	CIE. Lab values L*	a*	b*	Shear Force (kg)
C	71.7^{b}±2.11^{A}	8.3±0.87	13.6^{b}±1.32	5.7^{a}±0.23
SC	73.0^{a} ±1.87	9.6±1.23	14.8^{a}±1.11	5.8^{a}±1.32
MP	72.6^{b}±0.25	8.1±1.11	14.2^{a}±0.98	5.9^{a}±2.13
WP	72.7^{b}±0.43	8.1±1.12	14.1^{a} ±0.22	3.7^{b}±1.98
MIX	74^{a}.3±0.23	8.1±0.12	12.9^{b}±1.42	4.2^{b}±1.87

[A] Standart deviation Different lèvels in the same column indicate significant differences ($p<0.05$)

inversely with the ingredient and moisture content. Protein concentration in the control was slightly higher than in the remaining treatments and this is probably due to the higher moisture loss during cooking.

Water holding capacity, emulsion stability and cooking loss were given in Table 3 . The rolls extended with dairy ingredients had higher WHC. SC was the most effective ingredient on WHC, samples with SC had higher WHC. Adding MP or MIX had similar effects on WHC. As a result of a much more stable meat protein matrix is formed which leads to a smaller release of water and fat thus improving binding properties of restructured meats (Pietrasik and Whiting, 2003). Dairy ingredients significantly increased emulsion stability as indicated low total expressible fluid (TEF) of samples. The highest TEF percent (lowest emulsion stability) was found in control samples (27.3%). Effects of adding different milk proteins to comminuted meat products on emulsion stability have been investigated (Hughes *et al.*, 1997 and 1998 and Yetim, 2001). Fat retention levels of control samples were similar to samples with SC and MP. Other samples had higher fat retention values than control samples. The similar studies showed that use of dairy ingredients in emulsion batter decreased TEF and increased the emulsion stability (Sofos and Allen, 1977; Carballo *et al.*, 1995 and Hughes *et al.*, 1997 and 1998).

Cooking yields affected the cost of manufacture of processed meats. Control of cook loss is important because changes in cooking yield result in compositional changes in the finished product, that affect the palatability characteristics (Pietrasik and Whiting, 2003). WHC of roll batters affected the cooking losses similarly. The control batter with lower WHC had higher cooking losses. The roll batters with MP added showed lowest cooking loss. This trend corresponds with the report of Hung and Zayas(1992) that MP signifacantly improves battre stability

Table 5: Sensory evaluation results

Treatment	Appearance	Texture	Flavour
C	$5.8^a \pm 2.12^A$	$5.0^a \pm$ b1.21	$4.5^a \pm 2.11$
SC	$3.0^b \pm 1.23$	$3.7^b \pm 0.93$	$3.2^b \pm 1.09$
DM	$3.3^b \pm 0.43$	$2.8^b \pm 0.88$	$3.7^b \pm 0.98$
WPC	$3.1^b \pm 0.32$	$3.2^b \pm 1.22$	$3.2^b \pm 0.67$
MIX	$5.5^a \pm 0.99$	$6.5^a \pm 1.11$	$4.3^a \pm 0.77$

[A] Standart deviation Different levels in the same column indicate significant differences ($p<0.05$)

upon cooking. The highest cooking loss was obtained in control samples. MP was found the most effective ingredient with regard to cooking loss (Table 3). The higher protein content probably improved functionality of the emulsion products there by decreasing cooked loss (Hughes *et al.*,1997). No significant difference was found between treatments containing SC, WP or dairy mix as far as cooking losses were concerned. Meat products added to meat systems usually decrease the cooking loss and increase the moisture content of products (Ellekjaer *et al* ., 1996 and Hogenkamp, 1986). However in another research cooking yield has been reported not differ much with the addition of sodium caseinate at 1% residual level in frankfurters (Kerry *et al.*, 1998).
L* values of samples were ranged from 71.7 to 74.3. Dairy ingredients slightly increased lightness values of rolls. Control samples were darker than other samples. Addition of MP and WP increased lightness of rolls but did not significantly alter their redness. The differences in roll colour probably attributable to the dilution of myoglobin of meat. The addition of dairy ingredients dilutes myoglobin thus leading to increase lightness. Sammel and Claus (2003) reported that lightness of ground turkey increased with the addition of whey protein powder. Samples with Addition of dairy ingredients had no effect on a* values. Samples with dairy mix and control samples were less yellow (lower b* values) than other samples. Shear force values ranged between 3.75 and 6.65. There were no significant differences in shear force values of treatment groups except samples with WP and MIX. Only samples with WP and MIX had significantly different shear force values than control samples. El-Magoli *et al.*, (1996), investigated various levels (0-40 g/kg) of WP into low fat beef burger formulations. They found that with 30 g/kg WP, hardness and chewiness increased, but at a 40-g/kg level these attributes were reduced. Hung and Zayas (1992) reported that binders significantly improved hardness of frankfurters. Wassilew *et al.*, (1989) concluded that sausages with caseinate had firmer texture than sausages with WPP amd MP.
Sensory evaluation results were given in Table 5. Control samples and samples with dairy mix had higher apperance and texture scores. Flavour scores of rolls with dairy indredients were slightly lower than control but not significant. Hughes *et al.*, (1998) found that frankfurters with 3% WPC had similar flavour scores with control samples. This was probably due to lack of meaty flavour. This supports previous findings that sausages with whey protein concentrate (Hughes *et al.*, 1997) and skim milk powder (Ellekjær, 1996) had no effect on flavor. In contrast to our results Plimpton *et al.* (1972) and Holland, (1984) reported that sausages containing non fat dry milk and whey protein concentrate had significantly higher flavour scores.

Conclusion

Dairy ingredients improve emulsion stability, water holding capacity and cook losses of turkey rolls.Mixture of whey powder, sodium caseinate and milk powder may have the potential of improving technological quality and sensory palatability of emulsion type turkey rolls. But more research is needed on optimisation of the mixture to get better results.

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