Influence of Milk Co-precipitates on the Quality of Restructured Buffalo Meat Blocks

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ABSTRACT : Restructuring had made it possible to utilize lower value cuts and meat trimmings from spent animals by providing convenience in product preparation besides enhancing tenderness, palatability and value. Milk co-precipitates (MCP) have been reported to improve the nutritional and functional properties of certain meat products. This study was undertaken to evaluate the influence of incorporation of milk co-precipitates at four different levels viz. 0, 10, 15 and 20% on the quality of restructured buffalo meat blocks. Low-calcium milk co-precipitates were prepared from skim milk by heat and salt coagulation of milk proteins. Meat chunks were mixed with the curing ingredients and chilled water in a Hobart mixer for 5 minutes, followed by addition of milk co-precipitates along with condiments and spice mix and again mixed for 5 minutes. Treated chunks were stuffed in aluminium moulds and cooked in steam without pressure for 1.5 h. After cooking, treated meat blocks were compared for different physico-chemical and sensory attributes. Meat blocks incorporated with 10% MCP were significantly better ($p<0.05$) than those incorporated with 0, 15 and 20% MCP in cooking yield, percent shrinkage and moisture retention. Sensory scores were also marginally higher for meat blocks incorporated with 10% MCP than product incorporated with 15 and 20% MCP, besides being significantly higher than control. On the basis of above results 10% MCP was considered optimum for the preparation of restructured buffalo meat blocks. Instrumental texture profile analysis revealed that meat blocks incorporated with 10% MCP were significantly better ($p<0.05$) in hardness/ firmness than control although, no significant ($p>0.05$) differences were observed in cohesiveness, springiness, gumminess and chewiness of both type of samples. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 4 : 564-568)***

Key Words : Restructured, Buffalo Meat, Meat Blocks, Milk Co-precipitates, Meat Chunks, Sensory Attributes

INTRODUCTION

There is a tremendous increase in consumer demand towards consumption of low fat, cheap and good quality meat products. Buffalo meat, is abundantly available in India, and is low in fat as well as cholesterol. It can provide excellent quality meat proteins in various processed meat products. Buffalo meat from aged and spent animals is usually tough affecting its palatability (Paleari et al., 1997). Therefore, efforts should be directed on proper utilization of buffalo meat by developing various value added products. Development of restructured meat products prepared by utilizing less expensive meat cuts by reforming partially or completely disassembled meat, may be one of the best alternatives. Several benefits may be derived by the formation of restructured meat products such as proper utilization of low value cuts, portion control, uniformity in the product, improved tenderness, desirable shape of the product, extended shelf life, convenience of preparation etc. Main problems associated with restructured meat products are lack of proper binding, juiciness and discolouration. Therefore, there is a need of an agent which can overcome these problems.

Grant of GRAS status by USDA to milk proteins (Ensor et al., 1987) opened up a new area for quality improvement of meat products by incorporation of these proteins. A lot of research work is required to work out the most suitable milk protein and its level of incorporation in order to improve the functionality in restructured meat products especially with buffalo meat.

The following study was undertaken to evaluate the influence of incorporation of milk co-precipitates on the physico-chemical, sensory and textural proterties of restructured buffalo meat blocks.

MATERIALS AND METHODS

Ingredients and formulation

The meat for experiment was collected from spent female Murrah buffalo carcasses, within 4 h of slaughtered by a traditional Halal method. The meat mainly consisted of semitendinosus, semimembranosus, biceps femoris and quadriceps muscles. All visible fascia and external fat was trimmed off and meat was immediately kept in refrigerator (4±1°C) for conditioning for 24 h after packaging in low density polyethylene (LDPE). Buffalo meat was cut into chunks of about 2 cm^3 size before processing. Three batches of processed restructured buffalo meat blocks were prepared according to formula as in Table 1. In the treated groups, the lean meat was replaced by an equal weight of milk co-precipitates, respectively.

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Table 1. Formulation for preparation of restructured buffalo meat blocks

Ingredients	Weight (g)			
	Control	Treatment I	Treatment II	Treatment III
Lean meat	1,654	1,454	1,354	1,254
Milk-coprecipitate	-	200	300	400
Added water	200	200	200	200
Condiment mix	60	60	60	60
Table salt	40	40	40	40
Spice mix	30	30	30	30
Sucrose	10	10	10	10
Tetra sodium pyrophosphate	6	6	6	6
Sodium nitrite	3	3	3	3
Total	2,003	2,003	2,003	2,003

Preparation of milk co-precipitates

Low calcium milk co-precipitates (MCP) was prepared following the technique of Muller (1982) with slight modification. The skim milk was heated at 90°C for 2 min with continuous stirring. Calcium chloride at 0.2% (w/w) after dissolving in 1% distilled water was added in hot milk. This resulted in heat and salt coagulation of milk proteins. The coagulum was removed from curd by muslin cloth by applying pressure. The milk co-precipitates thus prepared had a mean moisture content of 65.48±0.46.

Product preparation

Measured quantities of chilled water, sodium chloride, sucrose, tetrasodium pyrophosphate and sodium nitrite were added to the weighted meat chunks and blended in Hobart mixer (Model: N-50) at a speed of 30 rpm for 5 min. This mixing was done for curing and extraction of proteins from meat chunks, which help in binding of meat chunks together during cooking. Then milk co-precipitates along with condiments and spice mix were incorporated at four different levels viz. 0, 10, 15 and 20%, respectively replacing lean meat in the formulation of control and it was mixed for another 5 min. The treated chunks were stuffed manually into the rectangular shape aluminium moulds (17.5 cm×7.5 cm×8.5 cm) and cooked in steam for 1.5 h to reach a core temperature of 75±2°C as well as to ensure adequate cooking. Thus, 8 meat blocks were made per batch, two blocks for each treatment. After cooking, the meat blocks were cooled to room temperature and after packing in low density polyethylene pouches (220 μm thickness) were kept at 4±1°C.

Chemical analysis

The pH of the sample was determined by the method of Strange et al. (1977). Ten g of sample was homogenized with 50 ml distilled water by using Ultra Turrex T-25 tissue homogenizer (Janke and Kenkel 9 KA Labor Technik, Germany) at a speed of 9,500 rpm for 1 min. The pH of suspension was recorded by immersing a combined glass electrode of a digital pH meter (Model: CP 901 Century Instruments Ltd. India). Six samples per treatment were analyzed for determining physico-chemical properties of restructured buffalo meat blocks. Moisture, fat and protein contents of cooked meat blocks were determined by using oven drying, Soxhlet ether extraction apparatus and Kjeldahl assembly, respectively, as per standard methods (AOAC, 1995).

Cooking yield was calculated from raw and cooked weights of meat the blocks. Length, width and height of each raw and cooked meat blocks were recorded to determine the percent shrinkage. The volume of raw and cooked blocks were calculated by multiplying length, width and height of the blocks. The percent shrinkage was calculated according to the following equation:

$$\text{Percent shrinkage}=\frac{\text{Volume of raw block-Volume of cooked block}}{\text{Volume of raw block}}\times 100$$

Moisture retention value represents the amount of moisture retained in the cooked product per 100 g of raw sample. It was calculated by multiplying cooking yield of meat blocks by moisture percentage in cooked blocks. Moisture protein ratio was calculated by dividing the moisture content of cooked blocks by protein content of cooked blocks.

Warner-Bratzler shear force value

For calculating the shear force value of cooked blocks, slices of 1 cm^2 were cut using food slicer. The slices were then placed perpendicular to the shear blade and sheared once using Warner-Bratzler shear press [Model: 81031307, G.R. Elect. Mfg CO., USA]. For each sample comprising one slice each from two blocks of a treatment, 10 observations were recorded to obtain the average value of shear force in Kg/cm^2 of cross sectional area.

Sensory evaluation

Sensory evaluation of the warm product was done by an experienced panel consisting of seven scientists and postgraduate students. Meat blocks were cut into 6 mm

Table 2. Means showing the effect of different levels of milk co-precipitates on the physico-chemical properties of cooked restructured buffalo meat blocks

Parameters	Control	Levels of milk co-precipitates(%)		
		10	15	20
Cooking yield (%)	71.18±0.88[a]	75.15±0.27[c]	73.49±0.27[b]	72.24±0.71[ab]
pH	6.11±0.35	6.13±0.02	6.14±0.01	6.18±0.04
Moisture (%)	65.53±1.00[a]	67.73±0.54[b]	66.67±0.25[ab]	66.00±0.26[ab]
Fat (%)	2.20±0.07[ab]	2.23±0.02[b]	2.10±0.11[ab]	2.00±0.07[a]
Protein (%)	20.62±0.06[a]	20.89±0.08[b]	21.05±0.07[b]	21.27±0.05[c]
Moisture to protein ratio	3.18±0.03[bc]	3.24±0.01[c]	3.17±0.01[b]	3.10±0.01[a]
Percent shrinkage (vol)	18.19±0.07[c]	17.23±0.27[a]	17.61±0.07[ab]	17.71±0.09[b]
Moisture retention (%)	46.63±0.77[a]	50.89±0.29[c]	48.99±0.32[b]	47.69±0.65[ab]
Shear force value* (kg/cm^2)	0.72±0.01[ab]	0.76±0.01[b]	0.73±0.01[ab]	0.70±0.01[a]

Means with different superscripts in a row differ significantly ($p<0.05$). n=6 observations per treatment. * n=30 observations per treatment.

thick slices and evaluated for sensory attributes viz. appearance, flavour, juiciness, texture, binding strength and overall acceptability using 8 point hedonic scale, wherein 8 denoted extremely desirable and 1 denoted extremely undesirable.

Instrumental texture profile analysis

On the basis of physico-chemical and sensory attributes, restructured buffalo meat blocks prepared by the incorporation of optimum level of milk co-precipitates were selected and these meat blocks were compared with control. The meat blocks were cut into 1 cm^2 and compressed to 50% of their original height with an Instron Universal Testing Machine (Model: 1000). A 50 N load cell was used with a load range of 0-50 N at crosshead and chart speed of 50 mm/min. Texture profile parameters; hardness/ firmness, cohesiveness, springiness, gumminess and chewiness were calculated using the method described by Brady et al. (1985). Ten samples were analyzed for each treatment per batch.

Statistical analysis

The experiment was repeated three times. The statistical design of this study was 4 (treatment)×3 (replication) randomized block design. The data was subjected to one way analysis of variance. Duncan's Multiple Range Test and critical difference were determined at 5% significance level (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Physico-chemical properties

The physico-chemical properties of restructured buffalo meat blocks incorporated with varying levels of milk co-precipitates (MCP) are presented in Table 2. Milk co-precipitates resulted in increased cooking yields at all levels of incorporation as compared to control. Cooking yield of meat blocks incorporated with 10% milk co-precipitates was significantly higher ($p<0.05$) than those containing 15 and 20% MCP which did not show a significant difference ($p>0.05$) between them. Increase in cooking yields in all the treated samples as compared to control was due to high water binding capacity of MCP as reported by several workers (Hynd, 1970; Rudolph and Hansen, 1986; Sen et al., 1994). Besides, Bhoyar et al. (1998) also reported that addition of MCP resulted in increased cooking yield in restructured chicken steaks as compared to control. There was a slight progressive increase in the pH of the product with increase in the level of MCP incorporation which might be attributed to calcium chloride whose conc. extraction increase with increase in the conc. extraction of milk co-precipitates.

Moisture content of meat blocks incorporated with different levels of MCP were higher as compared to control, although it was significantly higher ($p<0.05$) only in product containing 10% milk co-precipitates. Increase in moisture content with the incorporation of MCP was due to its high water binding capacity (Hynd, 1970; Kulikova et al., 1981; Muller 1982). Fat percentage differed significantly ($p<0.05$) between samples incorporated with 10 and 20% milk co-precipitates. Percent fat showed a declining trend with increase in the level of MCP which might be attributed to low percentage of fat in MCP itself. There was a significant increase in protein content with increase in the levels of milk co-precipitates. Protein contents of sample containing 10 and 15% MCP were comparable, although they differed significantly ($p<0.05$) from control and meat blocks with 20% milk co-precipitates. This observation could be due to high protein content of milk co-precipitates. Rudolph and Hansen (1986) and Patil (2000) also observed a significant increase in the protein content of meat products with increasing level of milk co-precipitates. Moisture to protein ratio of the meat blocks incorporated with 10% MCP differed significantly ($p<0.05$) from 15 and 20% MCP incorporated meat blocks, although it was comparable to the control. Highest value of moisture protein ratio for blocks containing 10% MCP was due to high moisture and less protein content as compared to other levels of MCP incorporation.

Table 3. Means showing the effect of different levels of milk co-precipitates on the sensory attributes of cooked restructured buffalo meat blocks

Attributes	Control	Levels of milk co-precipitates (%)		
		10	15	20
Appearance	6.48±0.08[a]	6.86±0.06[c]	6.76±0.09[bc]	6.60±0.08[ab]
Flavour	6.41±0.12[a]	6.95±0.09[b]	6.83±0.07[b]	6.71±0.11[b]
Juiciness	6.43±0.12[a]	6.98±0.07[b]	6.95±0.10[b]	6.86±0.07[b]
Texture	6.45±0.15[a]	6.95±0.09[b]	6.74±0.09[ab]	6.43±0.12[a]
Binding strength	6.36±z0.07[a]	6.91±0.10[c]	6.64±0.09[b]	6.45±0.10[ab]
Overall acceptability	6.38±0.09[a]	6.81±0.09[b]	6.69±0.07[b]	6.55±0.12[ab]

* Means with different superscripts in a row differ significantly ($p<0.05$). Mean values are scores on 8-point hedonic scale where 1:extremely undesirable and 8:extremely desirable. n=21 observations per treatment.

Table 4. Means showing the instrumental texture profile analysis for cooked restructured buffalo meat blocks

Parameter	Level of milk co-precipitates	
	0% (control)	10%
Hardness/Firmness (N)	20.25±1.44[a]	22.08±0.73[b]
Cohesiveness	0.63±0.02	0.58±0.01
Springiness (cm)	0.13±0.01	0.14±0.07
Gumminess (N)	12.70±0.87	11.95±0.53
Chewiness (N cm)	1.62±0.16	1.70±0.03

Percent shrinkage was minimum in sample incorporated with 10% MCP and it was significantly less ($p<0.05$) than sample incorporated with 20% MCP as well as control. Samples containing 15 and 20% MCP did not differ significantly ($p>0.05$) as compared to each other but they showed a significant decrease in percent shrinkage as compared to control. It was due to increased cooking yield and water absorption. Moisture retention was highest in meat blocks incorporated with 10% MCP and it decreased significantly ($p<0.05$) with increase in MCP levels as well as control. Maximum moisture retention by 10% MCP incorporated product might be due to maximum water absorption at this level. Shear force value of control was comparable to meat blocks at all level of MCP incorporation. However meat blocks containing 10% MCP showed a significantly higher ($p<0.05$) shear force value than ones incorporated with 20% MCP, which could be due to higher binding strength of former product.

Sensory attributes

Mean sensory scores for restructured buffalo meat blocks incorporated with varying levels of MCP are presented in Table 3. All the treated samples scored better in appearance than control probably due to compact look and better texture. A progressive decline in appearance was observed with increase in MCP incorporation, which might be due to simultaneous increase in whiteness of product. There was significant increase ($p<0.05$) in flavour scores at all levels of MCP incorporation than control, although treated samples were comparable among themselves. Increase in flavour with the incorporation of MCP might be attributed to the presence of lactose in MCP which acted as flavour enhancer (Thomas et al., 1976; Santos et al., 1994). All the treated samples rated significantly better ($p<0.05$) for juiciness than control, although these were comparable among themselves. Increase in juniciness in all the treated samples could be due to comparatively high absorption of water by milk co-precipitates. Bhoyar et al. (1998) reported that incorporation of MCP upto 20% level enhanced the juiciness and overall acceptability of restructured chicken steaks.

Meat blocks incorporated with 10% MCP scored highest with respect to texture and were comparable to the product incorporated with 15% MCP but differed significantly ($p<0.05$) with blocks treated with 20% MCP and control. Sanderson (1988) also reported that the use of co-precipitates could prove more effective in food applications particularly in modifying texture. Product incorporated with 10% MCP rated significantly higher ($p<0.05$) in binding strength than meat blocks incorporated with 15 and 20% MCP as well as control. There was a progressive decline in binding strength with increase in the level of MCP incorporation. This represents that MCP at 10% level acted more as a binder but at higher levels it acted more as a filler. Overall acceptability of the products incorporated with varying levels of MCP rated higher than control. Meat block with 10 and 15% MCP incorporation resulted in significant increase ($p<0.05$), whereas those with 20% MCP incorporation showed marginal increase in overall acceptability as compared to control. Santos et al. (1994) reported a general improvement in the sensory quality of meat products incorporated with milk co-precipitates. Kesava Rao et al. (1998) also observed that incorporation of MCP upto 10% level in low fat mutton balls improved the flavour and overall acceptability.

Instrumental texture profile analysis

On the basis of above physico-chemical and sensory attributes, restructured buffalo meat blocks prepared by the incorporation of 10% milk co-precipitates were considered best. These meat blocks were compared with control for instrumental texture profile analysis which are represented in Table 4. Incorporation of milk co-precipitates at 10%

level significantly improved ($p<0.05$) the hardness/ firmness of restructured meat blocks as compared to control. Increased hardness/ firmness in MCP incorporated meat blocks might be attributed to excellent binding and gelling nature of milk co-precipitates. Cohesiveness and gumminess of meat blocks prepared by incorporation of 10% MCP was marginally lower ($p>0.05$) than control. No significant differences ($p>0.05$) were observed in springiness and chewiness of treated sample and control.

CONCLUSSIONS

Milk co-precipitates can successfully be utilized for the preparation of restructured meat blocks which not only give significantly better ($p<0.05$) cooking yield and less percent shrinkage but also improve the scores for most of the sensory attributes than control. The restructured buffalo meat blocks prepared with the incorporation of 10% MCP were rated as the best, since 15 and 20% MCP incorporation resulted in an inferior product.

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