EFFECT OF MILK CO-PRECIPITATES ON QUALITY CHARACTERISTICS OF PORK SAUSAGES

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ABSTRACT

This experiment was carried out to study the influence of calcium milk co-precipitates on the quality of pork sausages. Three levels i.e low, medium and high calcium milk co-precipitates was used separately. The co-precipitated sausages were stored at refrigerated (7±1°C) temperature for a period of 15 days of storage period. Sausages with high calcium milk co-precipitates had lower (P<0.01) percent cooking loss than low, medium calcium milk co-precipitates and control. Sausages with medium calcium milk co-precipitates had higher emulsion stability values than rest of the formulations. Sausages with high calcium milk co-precipitates had slightly more percent moisture and percent total protein than rest of the formulations. Thiobarbuteric acid (TBA) values were increased (P<0.01) in all treatments during refrigerated (7±1°C) storage. Total plate count was more (P<0.01) in medium calcium milk co-precipitates treated sausages than rest of the formulations. Organoleptic scores were higher for sausages with high calcium milk co-precipitates when compared with control and other formulations. As the progressing of refrigerated (7±1°C) storage, the reduction of organoleptic scores was noticed in all formulations of pork sausages. Sausages in all the treatments were fit for consumption upto 10 days even though organoleptic scores were significantly lower compared to 0 and 5th days of storage.

Key Words: Milk co-precipitates, Quality characteristics, Refrigerated storage, Pork sausages

INTRODUCTION

The requirement for meat based convenient foods has increased many folds in the past two decades and is likely to increase further with the industrialization and peoples awareness about protein requirements which ends up with difficulty to meet the demands of meat. Further, due to high cost of meat, the common consumer cannot afford to purchase them regularly. So there is a necessity to overcome shortage of animal proteins and also to reduce the cost of meat products. Pork products find more acceptances over a large population because of their ease of production, lower cost and consumer appeal.

Judicious utilization of milk proteins (Proteinaceous products from the surplus skim milk of dairy industry) improves the sensory quality and nutritive value of comminuted meat products. Presently, researchers have focused increasing

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attention to utilize milk proteins as fillers, binders and extenders in various processed meat products (Sen 1993; Kondaiah et al. 1994). Milk proteins such as casein and caseinates, co-precipitates, skim milk power and whey proteins etc. substituted more expensive meat proteins and maximized the yield of the product. Dairy proteins improved emulsifying capacity, emulsions stability and water holding capacity of the batter and slicing characteristics of the product. In addition, the nutritive value of the end product is enhanced by their excellent amino acid profile (Jonas 1973), besiding improving sensory characteristic of the finished product. Several workers attempted to improve comminuted meat products using caseinates (Visser 1984; Jordan 1991; Hung and Zayas 1992). However, information available in the literature on the use of co-precipitates is scanty. Hence the present study was undertaken to assess the quality of pork sausages incorporated with different levels and types of calcium milk co-precipitates.

MATERIALS AND METHODS

Milk co-precipitates low, medium and high calcium co-precipitates were prepared from fresh cow milk by the method of Fox (1992). Intestines of sheep were used for sausage casings. The coarsely ground, cured lean pork was mixed thoroughly with seasoning and ground through 3 mm plate to evenly distribute the fat and seasoning. Then the meat mince was divided into 4 separate portions. One part was kept as untreated (T_1) and other 3 parts were added with 10% of low (T_2), medium (T_3) and high (T_4) calcium co-precipitates. Each emulsion was stuffed into sheep casings with a hand stuffer and finally sausage links were made. After stuffing and linking, the raw sausages were divided into four batches, one batch was used on same day of preparation (0 day) for evaluation and remaining three batches of sausages were packed in polyethylene bags, stored at refrigeration temperature (7±1°C) for evaluation on 5, 10 and 15 days of storage. Untreated samples were kept as control at refrigeration temperature. The stored sausages were subjected to subsequent evaluation for the following physico-chemical characteristics like percent cooking losses, emulsion stability, pH and Thiobarbituric acid (TBA) value, proximate composition i.e. percent moisture and percent total protein and microbiological characteristics like total plate count and total psychrophilic count and organoleptic evaluation. Percent cooking loss during storage was calculated by the difference between the initial and final cooked weight of the product. Emulsion stability (Baliga and Madaiah, 1970), pH (Jay *et al.,* 1964), TBA values (Tartaldis *et al.,* 1960) was estimated. AOAC (1994) methods were followed for estimation of percent moisture and percent protein. Samples from each group at different time intervals (0, 5and 15days) were microbiologically analyzed for mesophils and psychrophils as per the procedures described by Chestnut *et al.* (1977). All parameters were estimated on triplicate samples from each group. Sensory evaluation of pork sausages was carried out by a five member semi trained taste panel for colour, flavor, juiciness, tenderness and overall acceptability on a 9- point hedonic scale. The experimental data was subjected to statistical analysis (Snedecor and Cochran, 1980). Analysis of variance of two way classification was used for analyze the data. Least significant differences were calculated at appropriate level of significance.

RESULTS AND DISCUSSION

The results of control (T_1) sausages and influence of low (T_2), medium (T_3) and high (T_4) calcium milk co-precipitates on physico-chemical characteristics of pork sausages under refrigerated (7±1°C) storage were depicted in Table No: 1. The mean percent cooking losses of high calcium milk co-precipitates was significantly ($P<0.01$) lower than those of control, low and medium calcium milk co-precipitates. The mean values of percent cooking losses of pork sausages were significantly affected by storage periods. Irrespective of type

Table 1

Influence of various levels of calcium milk co-precipitates on physico- chemical characteristics of pork sausages during refrigerated (7±1°C) storage.

Storage period (days)	Percent cooking loss				Percent emulsion stability				pH				TBA values			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
0	40.3± 0.64 ^{A}	24.8± 0.91^{A}	26.8± 2.02^{A}	23.4± 1.62^{B}	8.01± 0.25^{A}	7.02± 0.15 ^{A}	6.65± 0.58 ^{A}	7.60± 0.37^{A}	5.95± 0.03^{A}	6.29± 0.01 ^{A}	6.30± 0.02^{A}	6.25± 0.09^{B}	0.67± 0.05^{A}	0.45± 0.05^{A}	0.34± 0.02^{A}	0.33± 0.09^{A}
5	44.6 ± 0.63 ^{A}	29.7± 0.40^{B}	28.1± 1.74 ^{B}	25.1± 1.93^{C}	8.81± 0.26 ^{A}	7.51± 0.29 ^{A}	6.77± 0.64^{A}	7.98± 0.32^{B}	6.15± 0.03 ^{A}	6.39± 0.02 ^{B}	6.34± 0.02^{B}	6.31± 0.02^{C}	0.78± 0.04^{B}	0.57± 0.07^{B}	0.46± 0.02^{B}	0.38± 0.01^{A}
10	48.2 ± 0.40 ^{A}	34.0 ± 1.19^{B}	32.9 ± 1.13 ^{B}	28.2± 0.96^{C}	9.91± 0.10^{B}	8.18± 0.30 ^{B}	7.42± 0.48^{B}	8.89± 0.29 ^{C}	6.22± 0.01^{A}	6.42± 0.02 ^{B}	6.42± 0.01^{C}	6.40± 0.02^{C}	0.85± 0.03^{C}	0.72± 0.03^{C}	0.60± 0.05^{C}	0.54± 0.04^{B}
15	50.8± 0.43 ^{A}	35.3± 1.07^{B}	30.9± 1.20^{C}	32.2± 0.99 ^{C}	10.1± 0.21 ^{C}	9.51± 0.18 ^{B}	8.66± 0.32^{C}	9.39± 0.13^{C}	6.33± 0.02 ^{B}	6.53± 0.02 ^{C}	6.52± 0.02 ^{C}	6.49± 0.07 ^{C}	1.01± 0.02 ^{C}	0.87± 0.03 ^{C}	0.73± 0.07^{C}	0.75± 0.06^{C}

Table 2

Influence of various levels of calcium milk co-precipitates on microbial and proximate characteristics pork sausages during refrigerated (7±1°C) storage.

Storage period (days)	Total plate count				Psychrophilic count				Percent moisture				Percent protein			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
0	5.12± 0.11^{a}	4.32± 0.23^{a}	4.75± 0.24^{a}	4.60± 0.18^{a}	3.06± 0.03^{a}	3.04± 0.07^{a}	2.65± 0.12^{a}	2.93± 0.08^{a}	64.8± 0.18^{a}	68.3± 0.45^{a}	66.3± 0.36^{a}	69.3± 0.16^{a}	19.2± 0.60^{a}	20.7± 0.74^{a}	21.4± 0.52^{a}	21.9± 0.55^{a}
5	6.08± 0.18^{b}	5.85± 0.19^{b}	6.94± 0.39^{a}	6.20± 0.06^{a}	4.44± 0.25^{b}	4.40± 0.41^{a}	4.24± 0.21^{b}	4.04± 0.08^{b}	63.9± 0.39^{b}	67.1± 0.31^{b}	65.7± 0.52^{b}	68.1± 0.28^{b}	19.8± 0.24^{a}	22.3± 0.63^{b}	22.6± 0.57^{a}	23.7± 0.45^{a}
10	7.27± 0.16^{c}	6.91± 0.10^{b}	7.70± 0.15^{b}	6.85± 0.06^{b}	5.51± 0.16^{c}	5.78± 0.28^{b}	5.84± 0.18^{b}	5.84± 0.08^{b}	62.5± 0.22^{b}	65.4± 0.26^{c}	64.8± 0.36^{c}	65.8± 0.23^{b}	20.3± 0.25^{b}	23.4± 0.76^{b}	24.9± 0.43^{b}	25.9± 0.70^{b}
15	8.92± 0.06^{c}	8.04± 0.16^{c}	9.23± 0.21^{b}	8.86± 0.19^{b}	6.53± 0.17^{c}	6.66± 0.17^{b}	6.77± 0.12^{b}	7.05± 0.08^{c}	60.5± 0.44^{c}	62.5± 0.49^{c}	65.8± 0.65^{c}	63.0± 0.63^{c}	21.7± 0.28^{c}	24.7± 0.34^{c}	27.0± 0.46^{b}	27.9± 0.61^{c}

Note: Means bearing different superscripts within each criterion differ significantly (P<0.01).

Table No: 3 Influence of various levels of calcium milk co-precipitates on sensory quality of pork sausages during refrigerated (7±1°C) storage.

Storage period (days)	Colour				Flavour				Juiciness			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
0	6.47± 0.62^{a}	7.26± 0.26^{b}	7.70± 0.41^{a}	8.84± 0.11^{a}	7.52± 0.31^{a}	7.51± 0.37^{a}	8.45± 0.20^{a}	8.90± 0.11^{a}	6.67± 0.13^{a}	7.50± 0.06^{a}	7.94± 0.02^{a}	8.82± 0.09^{a}
5	6.30± 0.51^{b}	7.20± 0.28^{b}	7.46± 0.35^{b}	8.33± 0.16^{a}	6.59± 0.58^{a}	6.62± 0.56^{a}	7.88± 0.23^{b}	8.58± 0.12^{a}	6.04± 0.20^{b}	7.14± 0.04^{b}	7.21± 0.09^{b}	8.06± 0.19^{b}
10	4.06± 0.22^{b}	5.63± 0.30^{b}	3.95± 0.27^{b}	5.26± 0.23^{b}	4.90± 0.21^{b}	5.22± 0.35^{b}	6.45± 0.72^{c}	5.99± 0.22^{b}	4.71± 0.26^{b}	5.97± 0.28^{c}	4.30± 0.13^{b}	6.03± 0.28^{c}
15	2.75± 0.13^{c}	3.48± 0.24^{b}	1.87± 0.14^{b}	2.76± 1.15^{b}	2.05± 0.04^{c}	2.83± 0.38^{c}	2.65± 0.18^{c}	2.75± 0.31^{b}	3.17± 0.28^{b}	3.14± 0.05^{c}	2.68± 0.20^{b}	3.42± 0.14^{c}

Storage period (days)	Tenderness				Overall acceptability			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
0	6.89± 0.17^{a}	7.96± 0.20^{a}	8.24± 0.16^{a}	8.63± 0.15^{a}	6.85± 0.21^{a}	7.65± 0.14^{a}	8.15± 0.13^{a}	8.82± 0.03^{a}
5	5.82± 0.23^{b}	7.27± 0.08^{b}	7.38± 0.15^{a}	8.22± 0.11^{a}	6.32± 0.18^{a}	7.05± 0.20^{b}	7.51± 0.12^{a}	8.31± 0.10^{a}
10	3.81± 0.31^{c}	5.13± 0.05^{b}	4.33± 0.15^{a}	5.75± 0.13^{b}	4.63± 0.19^{b}	7.51± 0.02^{c}	4.84± 0.31^{b}	5.55± 0.22^{b}
15	2.85± 0.26^{c}	3.20± 0.19^{c}	2.84± 0.48^{b}	3.54± 0.14^{b}	2.63± 0.14^{c}	8.31± 0.08^{c}	2.35± 0.12^{b}	3.09± 0.14^{c}

Note: Means bearing different superscripts within each criterion differ significantly ($P<0.01$).

of formulations, the storage period had increased the cooking losses of pork sausages. This might be due to the lowering of water binding capacity and loss of moisture during storage. These results were similar to those of Reddy and Rao (1997) in chicken meat patties who observed higher cooking losses at refrigerated (7±1° C) storage.

There was a significant (P<0.01) influence on emulsion stability of pork sausages by different formulations and storage periods. The pork sausage formulations extended with medium calcium milk co-precipitates recorded significantly better emulsion stability compared to those of low and high calcium milk co-precipitates added formulations and control. The significant increase in emulsion stability in medium calcium milk co-precipitates might be due to incorporation of binders in the pork sausages. The overall mean emulsion stability significantly (P<0.05) decreased with increase in the storage period for pork sausages. This might be due to the increase in the cooking losses and protein denaturation associated with increase in the storage. Reddy and Rao (2000) also obtained similar results in chicken meat loaves stored for 12 days at refrigerated (7±1°C) storage.

The pork sausage formulations which were added with low, medium and high calcium milk co-precipitates separately recorded significantly (P<0.01) higher mean pH and TBA values compared to control. Irrespective of formulations, the mean pH and TBA values of pork sausages had significantly (P<0.01) increased as the storage period increased upto 15 days. This increase might be due to a concomitant increase of bacteria and oxidation of fatty acids and lipid peroxidation during storage. These results were similar to Singh and Verma (2000) in chicken meat patties extended with textured soya and Thomson *et al.,* (1983) in chicken meat patties who observed increased TBA values as the storage period increased upto 8 weeks.

The results of control (T_1) sausages and influence of low (T_2), medium (T_3) and high (T_4) calcium milk co-precipitates on microbial and proximate characteristics of pork sausages under refrigerated (7±1°C) storage were depicted in Table No: 2. The type of formulation had no significant effect on the mean total plate count and psychrophilic count of pork sausages. Irrespective of type of formulations, the overall total plate count of pork sausages increased significantly (P<0.01) and progressively as the storage (7±1°C) period increased. This might be due to the permissive temperature and relative availability of moisture and nutrients for the growth of the aerobes. A similar trend of significant increase in the mean total plate count under refrigerated storage was observed by Murthy (1986) in pork sausages, Nath *et al.,* (1995) in chicken patties and Rao *et al.,* (1999) in smoked chicken sausages. The mean psychrophilic counts of pork sausages were significantly (P<0.01) and gradually increase as the storage period increased due to permissive temperature for the growth of psychrophils. Similar findings were also reported by Sharma and Rao (1996) in chicken meat loaves extended with pea flour.

The overall percent moisture content of pork sausages had decreased significantly (P<0.01) as the storage period increased in refrigerated storage conditions. This decrease in the moisture might be due to loss of drip fluid and dehydrating effect of sodium chloride. These observations were in accordance with the findings of Reddy and Rao (1997) in chicken meat patties, Reddy and Vijaylakshmi (1998) in chicken sausages who had recorded decreasing percent moisture with the increasing storage periods. Refrigerated storage (7±1°C) of pork sausages for 15 days had caused a significant increase in the mean percent total protein content. This might be due to the loss of moisture. Similar results of increasing crude protein were also obtained by Bawa *et al.,* (1988) in chicken meat sausages and Reddy and Vijaylakshmi (1998) in chicken meat sausages.

The results of control (T_1) sausages and influence of low (T_2), medium (T_3) and high (T_4) calcium milk co-precipitates on sensory characteristics of pork sausages under refrigerated (7±1°C) storage were depicted in Table No: 3. The formulations of pork sausages added with high calcium milk co-precipitates recorded significantly ($P<0.01$) higher mean colour, flavor, juiciness, tenderness and overall acceptability scores than the low, medium calcium milk co-precipitates and control. These higher scores might be due to the addition of binders, which improves the flavor precursors in meat and higher shrinkage during cooking and breakage of intra and inter molecular cross linking between the polypeptide chains of collagen during mincing of the meat. Irrespective of type of formulations and type of storage conditions, the mean colour , flavor, juiciness , tenderness and overall acceptability scores of pork sausages decreased significantly ($P<0.01$) with increasing storage period. This reduction in mean colour scores of stored pork sausages might be due to oxidative fading, the reduced flavor scores might be due to the fat oxidation during storage and reduced juiciness and tenderness scores might be due to loss of moisture and fat as the progressing of storage period. Similar type of results were noticed by Pangas *et al.*,(1999) in fried chicken liver, Rao *et al.,(*1999) in chicken sausages added with whey protein concentrate upto 2.5 percent level and Bhoyar *et al.*, (1998) in restructured chicken steaks extended with 10 percent textured soy protein.

Based upon the above findings, it is further concluded that sausages in all formulations fit for consumption upto 10 days even though organoleptic scores were significantly lower compared to 0 and 5 days of storage.

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