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Calcium Fortified Value Added Goat Meat Spread

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Abstract A present study was conducted to develop calcium fortified value added goat meat spread as a healthier alternative to modifying individuals' food choices or relying on voluntary supplement taking. Fortification of goat meat spread with short-fall nutrients is probably the best strategy for dealing with widespread nutrient deficiencies since it has the best chance of reaching the population segments most at risk. Effects of Calcium fortified value added goat meat spread prepared with different levels of calcium carbonate viz., 25, 50 and 75 per cent as per RDA prescribed by ICMR on physico-chemical, instrumental color, textural profile and sensory quality. Significant ($P \leq 0.05$) increase in pH while highly significant ($P \leq 0.01$) increase in cooking yield of goat meat spread was observed with increase in concentration of calcium carbonate. Further, instrumental colour in respect to redness (a^*) of spread was highly significant ($P \leq 0.01$) decrease and highly significant ($P \leq 0.01$) increase in lightness (L^*). Texture profile quality of goat meat spread was highly significant ($P \leq 0.01$) increase in respect to hardness, adhesiveness, cohesiveness, gumminess and chewiness whereas highly significant ($P \leq 0.01$) decrease in springiness were observed with an increase in incorporation of calcium carbonate. Statistically non significant ($P \geq 0.05$) decrease in all the sensory attributes of goat meat spread were observed upto 50% incorporation of calcium carbonate. Thus, on the basis of results it can be concluded that the fortification of 50% calcium carbonate as per RDA prescribed by ICMR was suitable for development of value added goat meat spread.

Keywords: *spread, instrumental colour profile, textural profile, sensory quality*

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1. Introduction

India ranked second in world goat population with about 148.88 million goats (as per 20th livestock census) and it contributed about 13.35% to total meat production in India. Goat meat is a good choice for manufacture of comminuted meat products [1]. Goat meat is leaner than other red meats and higher in desirable fatty acids with less saturated fat [2]. In addition, goat meat has lower percent of saturated fatty acid than chicken, beef, pork and lamb [3]. Goat meat is ideal for health conscious consumers because of its fatty acid profile [4] with high ratio of PUFA/SFA (0.45) [5] and the proportion of n-6/n-3 of less than 5 [6].

It is well known that the goat meat has very high nutritive value. The amino acids of goat meat are alike to those required for maintenance and development of human tissue. Meat is an excellent source of iron and phosphorous and some of the B-complex vitamins (thiamine, riboflavin, niacin, pyridoxine and cobalamine) but a poor source of calcium with only 10 mg/100 g of meat [7].

Meat obtained comes from spent goat is tough, fibrous and dark brown after cooking and also the meat lacks juiciness, flavour and texture. The dark red colour of spent meat is due to relatively more myoglobin content. Toughness of spent meat increases with age of the animal which not only increases the muscle fiber thickness but also increases the collagen tensile strength close to non-reducible intermolecular cross-links in older animal collagen. Efficient utility of spent goat meat could be achieved by breaking down the muscle fibres along with collagen fibers into fine particles by means of mincing and chopping which makes the meat suitable for its conversion into variety of value added products.

The phenomenal growth of snacks industry all over the world has brought an appreciable change in consumption pattern of food items as well as in the profitability of snack industry. Snack industry can fulfil the short term hunger and generally is comprised of bakery products, ready to eat mixes, chips, pretzels, crackers, cookies, bar, namkeen and other lightly processed ready to eat foods. The majority of market snacks are cereal-based, rich in calories and lack of important amino acids such as tryptophan, threonine and lysine [8]. Many Indian families, especially those in urban regions with higher education, prefer ready-to-eat meat snacks. Spreadable products are a variety of convenience snack meant to be spread on or sandwiched in a base like bread. Spreads are used to improve the flavour and/or texture of meals. Many such products are available like cheese spread, mayonnaise, jam and jelly in Indian convenient snack market. However, spreadable meat product is not very common yet among Indian consumers. The overall meat snacks market is growing because of various factors such as demand for low calorie and high quality protein content food products by health conscious consumers.

The major reason for fortification of diets is the decline in per capita calorie expenditure due to urbanization and the corresponding need to reduce energy intake. This reality, together with an increase in energy dense and poor nutrient foods, results in important shortfalls of many key essential elements and other nutrients in contemporary diets in contrast with the diets.

In human diet calcium is one of the most important nutrient which confers structural integrity to mineralized tissue (where about 99% of total calcium is found) along with playing a diverse role in maintaining cellular function. Interest in dietary calcium has increased in recent years as a result of scientific evidence linking it to major diseases like osteoporosis, hypertension and cancer. There is some evidence to support the hypothesis that increased calcium intake will reduce the risk for the above diseases (Cumming *et al*., 1997). This deficiency could be controlled by fortification of calcium in food to maintain the adequate calcium level. According to a map released by the International Osteoporosis Foundation (IOF), a non governmental organisation, India's average daily calcium consumption is only 429 mg, well below the RDA recommendation. Indian Council of Medical Research (ICMR) recommends an intake of 600-800 mg/day of calcium which may increase to 1200 mg/day in pregnant and lactating mothers [9].

The most common types of calcium added to food and beverages are calcium carbonate and calcium citrate. Calcium lactate, calcium chloride, calcium phosphate and calcium gluconate are some of the other calcium salts used in products [10]. The uses of different calcium salts depend on several factors like bioavailability, solubility, flavour impact, interactions with food ingredients in which the first two are the most significant. Hence, this study is carried out to study the processing, nutritional, textural and sensory quality of value added goat meat spread fortified with calcium carbonate.

2. Material and Methods

The study was conducted in the Department of Livestock Products Technology (Meat Science), Madras Veterinary College, TANUVAS, Chennai-600007 (TN) in the year 2021-22. Spent goat meat samples required for the experiments were purchased from local market at Vepery, Chennai-07. Meat was deboned after 24 hrs. of chilling at 4 ± 1°C. All visible fat, fascia, and connective tissue were removed, and the meat was minced twice in a meat mincer through a 4.5 mm sieve. Minced meat was conditioned for nearly 24 hours after being packaged in a colourless low density polyethylene (LDPE) bag at 4 ± 1°C in a refrigerator and then maintained at -18 ± 1°C. Before product preparation, the meat was thawed at 4 ± 1°C for 12 hr. The condiment paste of onion, garlic and ginger in the ratio of 3:2:1 was used. Spice ingredients, procured from the local market were dried at 50 ± 1°C for 4 hr. in a hot air oven. Food grade calcium carbonate was procured from Opera Chemisol India (P) Ltd., Chennai (TN). The ingredients were finely ground, sieved and added in fixed proportions as shown in Table 1 suggested by [11].

Table 1. Composition of spice mix for meat spread

Sr. No.	Ingredients	% in the mix
1.	Coriander powder (Dhania)	25.0
2.	Cumin seeds (Zeera)	12.0
3.	Dried ginger (Sont)	10.0
4.	Aniseed (Soanf)	10.0
5.	Black pepper (Kali mirch)	10.0
6.	Caraway seed (Ajowan)	05.0
7.	Turmeric (Haldi)	05.0
8.	Capsicum (Mirch powder)	08.0
9.	Cardamom (Badi elaichi)	05.0
10.	Cinnamon (Dal chini)	05.0
11.	Cloves (Laung)	03.0
12.	Nutmeg (Jaiphal)	01.0
13.	Mace (Jaipatri)	01.0

2.1. Processing of Meat Spread

The present study was carried out in the following steps to formulate the goat meat spread by incorporation of different levels of food grade calcium carbonate at 25% (0.75gm), 50% (1.5gm) and 75% (2.25gm) as per RDA prescribed by ICMR incorporations. The braising technique was used to cook the (Table 2) ingredients as subjected by Raziuddin *et al.* [12]. The developed value added goat meat spread fortified with calcium carbonate was analyzed on the basis of physico-chemical analysis, instrumental color profile, textural profile analysis, sensory evaluation and proximate composition.

Table 2. Formulation for the processing of value added goat meat spread fortified with calcium

Ingredients %	Supplementation of calcium as per the RDA			
	C	T1 (25%)	T2 (50%)	T3 (75%)
Spent goat meat	48.3	48.3	48.3	48.3
Salt	2.23	2.23	2.23	2.23
Spice mix	1.47	1.47	1.47	1.47
Skimmed milk powder	1.86	1.86	1.86	1.86
Condiments	5.95	5.95	5.95	5.95
Corn starch	2.97	2.97	2.97	2.97
Paprika	1.0	1.0	1.0	1.0
Honey	3.0	3.0	3.0	3.0
Butter	3.0	3.0	3.0	3.0
Calcium carbonate	0	0.75	1.5	2.25
Water	30.22	29.47	28.72	27.97

C-Control, T1- 25% (0.75gm), T2-50% (1.5gm) and T3-75% (2.25gm) of calcium carbonate source of calcium as per the RDA.

Process protocol of value added goat meat spread:

Salt, spices and other ingredients were mixed into the cooked goat meat. Mixing the ingredients completely and cooked by braising (85 ± 2°C for 12 min). Cooling and adding honey in final product and grinding for 3-4 min. to get fine paste like consistency. Product was stored at ambient temperature till evaluation.

2.2. Products Analysis

A. Physico-chemical analysis

1. Determination of Cooking Yield

Product yield was determined as per the method outlined by Verma *et al*. [13]. The product yield was determined using the equation and the weights before and after cooking.

Weight of product after cooking

$$Cooking\ yield\ \% = \frac{Weight\ of\ product\ after\ cooking}{Weight\ of\ product\ before\ cooking} x100$$

2. pH

A pre-calibrated digital pH meter was used to determine the pH of the product slurry. (Cyberscan pH 510, Merck). The slurry was prepared by homogenizing 5g of sample with 45 ml of distilled water in a laboratory blender for one minute following the procedure of Trout *et al*., [14].

3. Spreadability

The gel's spreadability was determined using the following method [15]: A circle of 1 cm diameter was premarked on which 0.5 g gel was deposited and a glass plate over which a second glass plate was placed. A weight of 500 g was allowed to rest on the upper glass plate for 5 min. The spreading of the gel caused an increase in the diameter.

B. Instrumental color analysis

Each sample's colour was evaluated in triplicates using a Hunter lab Mini scan XE plus Spectro-colorimeter with a D65/10° illuminant (Model No. 45/O-L, Reston Virginia, USA) [16]. The absorbance was expressed as L* (brightness), a* (redness) and b* (yellowness). The hue (relative position of colour between redness and yellowness) and chroma (colour intensity) was calculated as follows.

$$Hue = tan^{-1}\left(b*/a*\right)$$

$$Chroma = \sqrt{\left(a*\right)^2 + \left(b*\right)^2}$$

C. Textural profile analysis

Texture profile analysis was carried out using a Stable Microsystems Texturometer (Stable System Ltd., England, UK) model TX_HD plus texture analyser attached to a software texture expert system. The texture profile was analysed as per the procedure outlined by Bourne [17]. Triplicate samples in each trial were compressed twice to form a two work force compression curve. A cylindrical probe of 25 mm (P/25) diameter was used and the load cell capacity was 500 kg with a load range of 0-500 kg at cross head and char speed of 50 mm/min. Distance between probe and base is calculated according to the height of the product such that the probe compresses half of the product. The pre-test, test and post-test speed were 1 mm/sec, 5 mm/sec respectively. The following parameters were determined:

D. Sensory Evaluation

The sensory evaluation of the spread was conducted using a nine-point descriptive scale [18] with minor modifications, with 9 indicating excellent and 1 indicating extremely poor. Total 15 judges were used as a sensory panellist consisted of Professors and Postgraduate students of the Livestock Products Technology Division (Meat Science) of Madras Veterinary College. Fresh goat meat spread along with bread was served to the panellists. The panellists assessed the samples based on their overall appearance, flavour, spreadability, texture, aftertaste, adhesive ability, and acceptability.

E. Proximate Analysis

The moisture, crude fat, crude protein, and total ash of the value added goat meat spread were determined using the Association of Official Analytical Chemists' standard techniques [19].

F. Determination of calcium

Samples were analysed for the estimation of calcium content using (The Agilent Technologies 720 series). Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)

1. Digestion of samples

The samples were digested by wet digestion method for the analysis of calcium by following the procedure of Jankeaw *et al*. [20]. One gram of sample was taken in 25 ml glass screw cap test tube. 5 ml of 69 % concentration of nitric acid (Sigma aldrich) was added to the samples and kept in water bath at 80°C for 15 minutes. After that the test tubes were cooled to room temperature for 10 minutes and kept in hot air oven at 135°C for 3 minutes. After cooling them to room temperature 1 ml of 30 % hydrogen peroxide solution was added to the contents and filtered through Whatman No. 1 followed by Whatman No. 42 filter paper separately. The extracted solution was quantitatively transferred into a 50 ml volumetric flask and the volume was made upto the mark (*i.e* 50 ml) with millipore water and immediately used for calcium analysis.

2. Quantitative determination

Calcium content of goat meat spread was determined at 396.847 Wavelength (nm) and recorded directly from the analysis scale of ICP and was calculated by the following equation according to ASTM, [21].

$$Calcium\ content\ \left(mg/100\ gm\right) = R\ x\ D/W$$

Where:

R= Reading of elemental concentration from the digital scale of ICP system

D = Dilution of prepared sample

W = Weight of the sample

G. Statistical Analysis

All the experiments were replicated six times (n-6), and the data generated was analyzed by statistical methods viz. one way ANOVA, mean ± S.D using SPSS software package developed as per the procedure of Snedecor and Cochran, [22] and means were compared by using Duncan's multiple range test, 1995.

3. Result and Discussion

3.1. Physico-chemical Quality of Value Added Goat Meat Spread

A significant (P≤0.05) increase in pH of goat meat spread was observed with increase in concentration of calcium carbonate. This increase in pH were in agreement with Trout *et al.* [23], who reported incorporation of calcium carbonate at different levels significantly increased the pH of restructure pork chops. The cooking yield of products was increase highly significant (P≤0.01) with increase in calcium carbonate concentration. This increase in cooking yield were in agreement with Naveena *et al*, [24] who reported improved cooking yield of cooked chicken patties containing calcium lactate. Meat and meat products yield were related to fat and water retention [25]. The tendency of the non-meat elements to absorb water may be a factor in the changes in cooking yield of the meat spread [26]. There was a significant (P≤0.05) decrease in spreadability of the product with incorporation of different levels of calcium carbonate in goat meat spread but it was not affecting the actual spreadability quality of spread upto 50 % incorporation of calcium carbonate. The spreadability was an important character in uniform application of the products to the bread. Water activity of products was significantly (P≤0.05) decrease with increase incorporation of calcium carbonate from 25 % to 75 %. This decrease in water activity of spread were similar with Naveena *et al*, [24] who reported lower water activity of cooked chicken patties containing calcium lactate.

3.2. Instrumental Colour Profile Analysis of Value Added Goat Meat Spread

Highly significant (P≤0.01) increase in lightness (L^*) and highly significant (P≤0.01) decrease in redness (a^*) was observed with incorporation of different levels of calcium carbonate in goat meat spread. The present study's lightness levels were comparable to calcium-fortified beef frankfurters [27]. Further, they stated that level of lightening increased as the amount of calcium incorporation increased and decreased in redness of calcium fortified beef frankfurters. Significant (p<0.05) increase in yellowness (b^*) of goat meat spread was observed with increase in concentration of calcium carbonate whereas highly significant (P≤0.01) increase in hue angle. This increase in yellowness of meat spread was probably due to the decrease in redness of meat spread. The change in yellow colour of meat spread might be due to incorporation of calcium carbonate. Hue angle played an important role in determining the colour stability of meat and meat products [28]. Where, higher hue angle scores of product indicated lower redness [29].

3.3. Texture Profile Analysis of Value Added Goat Meat Spread

Hardness, adhesiveness, cohesiveness, gumminess and chewiness of goat meat spread were highly significant (P<0.01) increase with an increase in incorporation of calcium carbonate whereas highly significant (P≤0.01) decrease in springiness. The results of hardness were in concurrence with Trout *et al.* [23] who reported incorporation of calcium carbonate significantly increased hardness of restructured pork chops. This was probably due to calcium, a divalent cation, established bonds between meat protein mainly myosin and favoured the formation of a stronger network which led to the higher firmness [7]. Increase in adhesiveness of goat meat spread could be due to formation of a stronger network between calcium carbonate and meat protein. The results of springiness were in agreement with Trout *et al.* [23] who reported incorporation of calcium carbonate showed non significant (P≥0.05) effect on springiness of restructured pork chops. Incorporation of calcium carbonate might interfere with protein-protein interactions which could reduce springiness of product. The results of cohesiveness, gumminess and chewiness were in agreement with Boyle *et al.* [27] who reported incorporation of calcium carbonate revealed significant increase in cohesiveness gumminess and chewiness in frankfurter.

3.4. Sensory Quality of Value Added Goat Meat Spread

All the sensory attributes of goat meat spread were decrease significant (P<0.05) with incorporation of calcium carbonate. Further, it was found that statistically non significant (P≥0.05) decrease in sensory quality were recorded up to 50% incorporation of calcium carbonate. The lower appearance score for goat meat spread might be due to the increasing concentration of calcium carbonate. These results seemed to be correlated with instrumental colour where the redness (a^*) values were lower than the control. This decrease in flavor score of goat meat spread with increase incorporation of calcium carbonate might be due to the incorporation of calcium carbonate. The results of decrease in flavour score of goat meat spread were in agreement with Mehta *et al.* [30] who reported gradual decrease in the flavor score with an increase of calcium lactate incorporation in low-fat chicken meat patties. Brewer *et al.* [31] reported an intense flavor in fresh pork sausage containing 2 % and 3 % calcium lactate. Incorporation of 50 % calcium carbonate as per RDA prescribed by ICAR in goat meat spread slightly reduced the spreadability of products even though it was not affecting the actual spreadability of spread. Changes in texture quality could probably be associated to the relatively lowering moisture content of meat products after incorporation of calcium carbonate. Consumer panelist recorded significantly (p≤0.05) lower score for after taste at 75 % incorporation of calcium carbonate in value added goat meat spread. This decrease in score for after taste might be due to taste of calcium carbonate. These results of adhesiveness seemed to be correlated with texture profile analysis where the adhesiveness values were increased than the control. Present findings for overall acceptability score were agreement with both Mehta *et al.* [30] who reported decrease in the overall acceptability score with an increase of calcium lactate incorporation in low fat chicken meat patties.

Table 3. Physico-chemical quality of value added goat meat spread incorporated with different levels of calcium carbonate

Treatment	Physico-chemical quality			
	pH	Cooking yield (%)	Spreadability (cm)	Water activity
Control	5.87 ± 0.05[b]	85.66 ± 1.03[c]	3.15 ± 0.08[a]	0.960 ± 0.008[a]
T1	5.91 ± 0.24[b]	88.49 ± 1.09[b]	3.08 ± 0.08[ab]	0.954 ± 0.007[ab]
T2	6.13 ± 0.02[a]	90.04 ± 1.24[a]	3.04 ± 0.08[b]	0.950 ± 0.005[bc]
T3	6.20 ± 0.05[a]	91.02 ± 0 .60[a]	2.87 ± 0.09[c]	0.944 ± 0.001[c]
F Value	9.015*	31.441**	11.007**	6.956*

C: Control (n=6)
T1:25% (0.75gm) calcium carbonate source of calcium as per the RDA
T2: 50% (1.5gm) calcium carbonate source of calcium as per the RDA
T3: 75% (2.25gm) calcium carbonate source of calcium as per the RDA
Means bearing different superscripts within columns (a,b,c) differ significantly $P \leq 0.05$; NS- $P \geq 0.05$;*- $P \leq 0.05$; **- $P \leq 0.01$

Table 4. Mean ± SD values of Instrumental colour profile and textural profile analysis of value added goat meat spread incorporated with different levels of calcium carbonate

Parameters	Control	T1	T2	T3	F Value
Instrumental colour profile analysis					
Lightness (*L)**	51.05 ± 1.08[d]	56.87 ± 0.32[c]	59.11 ± 0.80[b]	60.89 ± 0.25[a]	219.732**
Redness (*a)**	12.04 ± 0.54[a]	10.41 ± 0.22[b]	10.03 ± 0.24[bc]	9.92 ± 0.20[c]	51.186**
Yellowness (*b)**	30.70 ± 0.47[b]	30.99 ± 0.42[b]	31.54 ± 0.20[a]	31.03 ± 0.42[b]	4.667*
Hue	0.9900 ± 0.00[c]	0.9933 ± 0.00[b]	1.0000 ± 0.00[a]	1.0000 ± 0.00[a]	22.500**
Chroma	32.98 ± 0.58	32.70 ± 0.42	33.10 ± 0.23	32.57 ± 0.41	1.876 NS
Textural Profile Analysis					
Hardness (g)	24.17 ± 0.59[d]	26.46 ± 0.88[c]	28.28 ± 0.84[b]	33.36 ± 0.88[a]	139.255**
Adhesiveness (g.sec)	117.88 ± 1.46[d]	97.13 ± 0.77[c]	55.42 ± 1.01[b]	37.51 ± 0.79[a]	7423.916**
Springiness	0.495 ± 0.05	0.490 ± 0.04	0.484 ± 0.04	472 ± 0.05	0.219NS
Cohesiveness	0.57 ± 0.05[c]	0.60 ± 0.08[bc]	0.67 ± 0.09[ab]	0.69 ± 0.05[a]	3.784*
Gumminess	16.68 ± 0.44[c]	21.61 ± 0.68[b]	22.24 ± 0.93[b]	26.25 ± 0.76[a]	174.980**
Chewiness	10.32 ± 0.70[b]	11.61 ± 0.82[a]	11.82 ± 0.70[a]	12.02 ± 0.52[a]	7.141*

C: Control (n=6)
T1:25% (0.75gm) calcium carbonate source of calcium as per the RDA
T2: 50% (1.5gm) calcium carbonate source of calcium as per the RDA
T3: 75% (2.25gm) calcium carbonate source of calcium as per the RDA
Means bearing different superscripts within columns (a, b, c, d) differ significantly $P \leq 0.05$; NS- $P \geqq 0.05$;*- $P \leq 0.05$; **- $P \leq 0.01$

Table 5. Mean ± SD values of Sensory quality of value added goat meat spread incorporated with different levels of calcium carbonate

Treatment	Sensory quality						
	Appearance	Flavour	Spreadability	Texture	After Taste	Adhesive Ability	Overall Acceptability
Control	8.13 ± 0.57[a]	8.26 ± 0.52[a]	8.06 ± 0.58[a]	8.30 ± 0.46[a]	8.20 ± 0.55[a]	8.03 ± 0.61[a]	8.36 ± 0.55[a]
T1	8.10 ± 0.71[a]	8.20 ± 0.55[a]	7.90 ± 0.60[ab]	8.20 ± 0.48[a]	8.10 ± 0.54[a]	7.90 ± 0.54[a]	8.20 ± 0.48[a]
T2	7.90 ± 0.40[a]	8.00 ± 0.58[a]	7.80 ± 0.76[ab]	8.06 ± 0.58[a]	7.96 ± 0.55[a]	7.76 ± 0.50[a]	8.20 ± 0 .48[a]
T3	7.53 ± 0.57[b]	7.50 ± 0.57[b]	7.60 ± 0.49[b]	7.70 ± 0.46[b]	7.66 ± 0.47[b]	7.43 ± 0.50[b]	7.50 ± 0.68[b]
F Value	6.893*	11.573*	2.972*	8.191*	5.641*	6.707*	14.366*

C: Control (n=6)
T1: 25% (0.75gm) calcium carbonate source of calcium as per the RDA
T2: 50% (1.5gm) calcium carbonate source of calcium as per the RDA
T3: 75% (2.25gm) calcium carbonate source of calcium as per the RDA
Means bearing different superscripts within columns (a, b) differ significantly $P \leq 0.05$; NS- $P \geq 0.05$; *- $P \leq 0.05$;**- $P \leq 0.01$

Table 6. Mean ± SD values of Nutritional quality of value added goat meat spread incorporated with different levels of calcium carbonate

Treatment	Nutritional quality				
	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Calcium (mg/100 g)
Control	66.33 ± 0.51[a]	20.99 ± 0.58	3.87 ± 0.52	3.38 ± 0.27[d]	29.00 ± 0.63[d]
T1	65.32 ± 0.53[b]	20.93 ± 0.53	3.83 ± 0.50	4.07 ± 0.52[c]	312.00 ± 1.41[c]
T2	65.10 ± 0.86[b]	20.89 ± 0.55	3.81 ± 0.55	4.82 ± 0.61[b]	620.00 ± 3.28[b]
T3	64.65 ± 0.48[b]	20.83 ± 0.43	3.75 ± 0.53	5.55 ± 0.62[a]	929.00 ± 1.67[a]
F Value	7.849*	0.105NS	0.053NS	18.779**	238867.375**

C: Control (n=6)
T1: 25% (0.75gm) calcium carbonate source of calcium as per the RDA
T2: 50% (1.5gm) calcium carbonate source of calcium as per the RDA
T3: 75% (2.25gm) calcium carbonate source of calcium as per the RDA
Means bearing different superscripts within columns (a,b,c,d) differ significantly $P \leq 0.05$; NS- $P \geqq 0.05$;*- $P \leq 0.05$; **- $P \leq 0.01$.

3.5. Nutritional Quality of Value Added Goat Meat Spread

Moisture content of spread was significantly (P≤0.05) decrease and non significant (P≥0.05) decrease in protein and fat content with increase incorporation of calcium carbonate. Present findings of moisture, protein and fat were agreement with Mehta *et al.* [30] also reported decrease in the moisture and protein with an increase of calcium lactate incorporation in low-fat chicken meat patties. This could be due to the property of calcium to compete with phosphate for protein binding site which causes limiting protein water interaction resulting less moisture in the products [32]. This decrease in fat content with an increase in the level of calcium carbonate could be due to the loss of some fat because of reduced stability of emulsion. A highly significant (P≤0.01) increase in ash content of goat meat spread was observed with incorporation of calcium carbonate. It could be probably due to direct addition of calcium salts. Naveena *et al.* [24] and Caceras *et al.* [33] who also reported significant increase in ash content in both microwave-cooked chicken patties and cooked sausages incorporated with calcium lactate. The calcium content in the fortified goat meat spread was found to be highly significant (P≤0.01) increase than that of the control. This could be due to the presence of calcium carbonate which has increased the concentration of calcium in the fortified goat meat spread. Similar increase in calcium concentration had been reported by Caceras *et al.* [33] and Mehta *et al.* [30].

4. Conclusion

In the present study, it was concluded that the incorporation of calcium carbonate to the value added goat meat spread without affecting the product quality and acceptability. Fortification of 50% calcium carbonate as per RDA prescribed by ICMR was suitable for development of value added goat meat spread without affecting the quality. For a normal adult male required tentative 80 gm of goat meat spread (600 mg/day) as well as lactating and pregnant women required 160 gm (1200 mg/day) to meet the RDA of calcium as per ICMR.

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Conflicts of Interest

The authors state that the publishing of this paper does not include any conflicts of interest.

Ethics Approval

Not Applicable.

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