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Quality characteristics of goat meat nuggets incorporated with edible goat by products

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Abstract

This study was conducted to evaluate the quality characteristics of goat meat nuggets incorporated with goat liver and kidney. Four combinations at different levels of liver and kidney were incorporated in goat meat nuggets formulations. Products were evaluated against the control for the physicochemical, texture profile, instrumental colour, sensory and microbial properties. The moisture content of the goat meat nuggets showed significant ($P<0.05$) increase (65.82 to 67.32%) and the protein content showed significant ($P<0.05$) decrease (14.20 to 13.41) due to the addition of liver and kidney. No significant difference was noticed for the texture, instrumental colour, sensory and microbial qualities among the control and treatment groups. The total plate count and yeast and mould count were within the limits and were free from coliform count which ensures the microbial safety of the product. Hence the use of edible by products like liver and kidney in goat meat nuggets is viable as it reduces the cost of raw materials and considered as the additional income for the producers. The utilization of edible by products, offers meat product of nutritional and sensory quality comparable with the regular goat meat nuggets.

Key words: Edible by products, goat meat nuggets, physicochemical property, microbial quality.

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Introduction

In the meat industry the utilization of slaughterhouse by products was highly focused on commercialization to reduce its environmental impact and cost of management of these waste (Brasil *et al*., 2014). Now a days consumption of edible by products form goat like liver, kidney, spleen and heart etc. was included in the food habitations especially for their nutritional benefits.The vitamin content of edible offal is usually higher than that of lean meat issue. Riboflavin content was found to be in highest amount in Kidney and liver (1.697 – 3.630 mg/100 g) and is nearly 5–10 times amount present in lean meat. Liver also

contains good amount of niacin, cobalamin, pyridoxine, folacin, ascorbic acid and vitamin A. Livers also contain the highest amount of manganese (0.128 to 0.344 mg/100 g) was reported by Irshad and Sharma (2015). Kidney is also a good source of cobalamin, pyridoxine and folacin (Toldra *et al.,* 2012). It is difficult to prepare whole product using the edible goat by products. However, edible by products can be utilized effectively by incorporating in processed meat products for the value addition. Limited studies are reported on the quality of meat products incorporated with edible by products. So, the present investigation was conducted to evaluate the quality characteristics of goat meat nuggets incorporated with goat liver and kidney as a substitute for lean meat to reduce its cost of production and to improve nutritive value. Therefore, the aim of this study was aimed to develop and analyse the physicochemical, texture profile, instrumental colour, microbiological properties and sensory attributes of goat meat nuggets prepared with different levels of combination of goat raw liver and kidney.

Materials and Methods

Barbari goats of 9 to 12 months were slaughtered and dressed in Experimental slaughter house unit of Goat Products Technology Laboratory, ANM & PT Division, ICAR - Central Institute for Research on Goats, Farah, Mathura, Uttar Pradesh. Dressed carcass were chilled, deboned manually and the meat obtained was packed in UV sterilized low-density polyethylene bags and stored in freezer at -18±1°C till further use. Liver and kidney obtained during the slaughter of Barbari goats were collected hygienically, cleaned, packed separately in UV sterilized LDPE bags and stored in a frozen condition (-18±1°C).Goat meat, liver and kidney were thawed overnight in a refrigerator and minced in a meat mincer (Model P-22, M/S Tallers Ramon, Barcelona, Spain) using 8 mm pate.

Preparation of goat meat nuggets

Control and different treatment groups were prepared separately by pre weighing the ingredients according to the formulation mentioned in Table3. Meat emulsion was prepared in a mixer grinder (Model Philips HR7629/90 650W Food processor) by orderly mixing of all ingredients. The minced meat along with liver and kidney were mixed with ingredients like common salt, sodium tripolyphosphate and sodium nitrite (dissolved with ice flakes) for the better extraction of protein. To this ice flakes, whole chicken egg, refined sunflower oil followed by condiments, refined wheat flour and dried spice mix were added and further mixed uniformly using mixer grinder for 30 sec. The obtained emulsion batter of 500 g was filled in a clean stainless steel mould. This was allowed for steam cooking for 35 min to get a core temperature of 80 ± 2°C in the product. The nugget blocks after cooled were sliced, cut into nuggets of size 15 mm thickness and packed in UV sterilized LDPE pouches for determining the various quality characteristics.

Analytical procedures

pH: The pH of the emulsion and goat meat nuggets were determined by blending 10gm sample with 50 ml distilled water and thoroughly homogenized by using the homogenizer (Model PT – MR – 2100, Kinematica AG, Luzern, Switzerland) for 1 min. The pH of the suspension was recorded by immersing the electrode of the digital pH meter (Model Mettler Toledo, Columbus, Ohio, USA). The pH meter was calibrated using standard buffers at a pH 4, 7 and 10 before measuring the pH of the samples (Trout *et al*., 1992).

Emulsion stability (ES) and cooking yield (CY): Emulsion stability was determined by heating 25gm emulsion samples at 80°C in a water bath for 20 min by turning the samples for every 10 min. The exudates were drained out, the cooked samples were weighed after it is cooled and the yield of the sample was expressed as the ES (%) (Verma *et al*., 2019).

Cooking yield was calculated by recording the weight of the emulsion, weight of the product after cooking and the yield of the product was expressed as CY (%).

Proximate composition: Moisture, protein, fat, ash, carbohydrate and energy values of liver and Kidney and goat meat nuggets were estimated in triplicates by using hot air oven, Kjeldahl assembly, Soxhlet extraction apparatus and muffle furnace as per the method of AOAC (2016).

Instrumental colour analysis

The colour values of the goat meat nuggets were monitored by evaluating Hunter L*(lightness), a* (redness) and b*(yellowness) value using Color Tech PCM+ (ColorTec Associates, Inc, Clinton, NJ). The hue (relative position of colour between redness and yellowness) and chroma (saturation/colour intensity) values were determined by using the formula, $Tan^{-1}(b^*/a^*)$ and $(a^2 + b^2)^{1/2}$, respectively (Little, 1975 and Froehilch *et al.,* 1983).

Texture profile analysis

The textural properties of nuggets were evaluated using Stable Micro-system (Model TA.XT 2i/25 Surrey, U.K.) by following the method of Bourne, 1978. The central core of each of the sample in duplicates of size 1.5 cm^3, were placed in the centre of the base plate or sample platform was compressed twice to 60% of the original height to form two bite workforce compression curves.

Sensory evaluation

Twelve members of trained sensory panel were evaluated goat meat nuggets using 8 points descriptive scale, whereas 8 denoted extremely desirable and 1 denoted extremely poor, 5 to 8 were considered acceptable (Das *et al.,* 2008). Samples were warmed using microwave oven for 1 minute and cut across their centre to make 8 equal size and shape were served to the panelist. Water was provided to rinse mouth between the samples. The panelist judged the samples for colour and appearance, flavour, juiciness, texture and overall acceptability.

Microbiological analysis

A 10gm sample of liver, kidney and goat meat nuggets were mixed thoroughly with 90-mL sterile 0.1% peptone water by using stomacher (Model Smasher, Biomerieux SA, France). Appropriate dilutions of samples were prepared in sterile 0.1% peptone water and plated, in duplicate with 1 ml of aliquot of appropriate dilution by using the pour plate method. Standard Plate Count Agar was used for total plate count (TPA), Potato dextrose agar for yeast and mould count and violet red bile agar for coliform count. Plates were incubated at35 ± 2°C for 24 h for total TPA and coliform count and for 25ºC for 5 days for yeast and mould count.Following incubation, plates showing 30-300 colonies were counted and expressed as $\log_{10}$ cfu/gm sample (APHA, 1984).

Results and Discussion

Quality characteristics of goat by products

Evaluation of nutritional quality of kidney and liver in the present study showed moisture (77.67 and 70.76%), protein (15.95 and 18.78%), fat (1.80 and 7.63%) and ash (1.30 and 1.42) (Table 1). Moisture content of the present study found similar to the findings of Umaraw *et al.*,(2018), Biel *et al.*,(2019) and Tomvic *et al.*,(2017). The protein % of the liver and kidney were similar to findings of Arguello *et al.*,(2005), Qwele *et al.*,(2013), Umaraw *et al.*,(2018) and Bristone *et al.*,(2018) and they also reported the highest value of protein in liver when compare to kidney. Marginally similar values for fat content of liver and kidney (2.62 and 7.63%) was found by Umaraw *et al.*,(2018) and dissimilar values was reported by Abdullah (2008), Biel *et al.*,(2019), Tomovic *et al.*,(2017). This could be due to factors such as age, breed, weight and feeding habits of the animal. Slightly higher value of ash content was reported by Arguello *et al.*, (2005) and Qwele *et al.,* (2013) and this may be due to the characteristics of breed used in their study. The carbohydrate value was found higher in liver compare to kidney and this might be due to the presence of glycogen in

liver (Umaraw *et al.,* 2018). The moisture protein ratio and energy value (kcal/g) of liver and kidney recorded in the present study was almost similar to value reported by Campbell and Kenney (1994) and Biel *et al*., 2019.

Microbial qualities, total plate count (4.48 and 4.47), yeast and mould count (2.73 and 2.91) and coliform count (1.37 and 1.96) of the liver and kidney in $\log_{10}$cfu/gm were presented in Table 2. Higher values of total plate count of 6.1 cfu/cm^2 and 6.11cfu/cm^2 in porcine liver was reported by Gardner (1971) and Woolthuis *et al.,* (1984). Devatkal *et al.,* (2004) concluded that the presence of higher total plate count and the Coliform group of organisms in the edible offals was acquired due to the on floor slaughter practices, contaminations from skin, hair and mishandling during evisceration. The yeast and mould contaminations were acquired from the environment as their spores was dispersed by means of dust and soil. Also, in the present study the microbial qualities of the liver and kidney were within the limitations as described by CFR is 10^6 cfu/g. So, the goat reared under good managemental conditions, hygienic slaughter practices and by proper collection and processing of offals, the edible goat by products like liver and kidney can be effectively utilized in products like goat meat nuggets as a meat replacer as it contains nutritional properties comparable with meat.

Physicochemical properties of goat meat nuggets incorporated with liver and kidney

The results obtained from the Physico-chemical properties of goat meat nuggets incorporated with different levels of combinations of liver and kidney at 1:1 ratio is presented in Table 3.

pH: There was no significant difference was found in the pH of the emulsion and product treated up to 3.5% of liver and kidney (1:1) and the same was reported by Biswas *et al.,*(2007) in the chicken sausage emulsion incorporated with chicken skin and fat. Devatkal *et al.,* (2004) and Dalmas *et al.,* (2011) also found non-significant results in the pH of 20% liver incorporated buffalo meat loves and 30% blood and liver incorporated goat meat patties. Contrary to the findings increase in pH was noted by Ozunlu *et al.,*(2019) and Biswas *et al.,*(2007) in beef patties treated with spleen incorporated beef patties and chicken fat and skin incorporated chicken sausage. This might be due to characteristic higher pH of the edible organs was exerted in the product when incorporated at higher level than 15%.

Emulsion stability and cooking yield: There was no significant difference was found in the emulsion stability and cooking yield among different treatments of goat meat nuggets. This indicated that combination of liver and kidney up to 3.5 % level in the present study had no influence on the emulsion stability and cooking yield of goat meat nuggets. Similarly, findings were reported by Verma *et al.,* (2008) for emulsion stability but increasing trend of cooking yield was observed in buffalo heart and head meat treated patties. On contrary Devatkal *et al*.,(2004) reported decrease in the emulsion stability and cooking yield of liver meat and liver vegetable loves.

Proximate composition: The proximate composition of goat meat nuggets incorporated with different levels of combination of liver and kidney at 1:1 ratio is presented in Table 3. The moisture, protein, fat and ash content of goat meat nuggets incorporated with different levels of combination of liver and kidney were between 65.82 – 67.32%, 13.41 – 14.20%, 13.49 – 13.15%, 2.78 – 2.82% respectively. The moisture percentage showed significant increase ($P<0.05$) whereas the protein content showed significant decrease ($P<0.05$), fat and ash content was found non-significant ($P>0.05$) in the treated goat meat nuggets when compare to the control. This may be due to the characteristic higher moisture (70.76 and 79.67%), and decreased protein content (18.78 and 15.95%) of liver and kidney compare to moisture (74%) and protein value (21%) of the goat meat (Umaraw *et al.,* 2018) when used as meat replacer. Dalmas *et al.,* (2011) and Devatkal *et al.,* (2004) reported increase in moisture content of the blood and liver (15 and 15%) incorporated goat meat patties and buffalo liver meat loafs respectively due to the

moisture retention ability of the liver. However, similar values of protein content (14.74 and 14.94%) was reported by Dalmas *et al.,* (2011) in goat liver patties and slightly higher value (15.1%)was reported by Amaral *et al.,* (2013) in sheep liver patties. Regarding fat content Rao *et al.,* (2011) observed that the increase in fat content was evinced when the edible offals was added at 10 to 30% in chicken sausage due to higher fat content present in offals than the chicken meat. This may be due to the fact that the raw liver and kidney incorporated up to 3.5% level had no impact on the fat % of goat meat nuggets. Similarly, there was no significant difference was noticed in carbohydrate and energy content of the control and treated goat meat nuggets.

Instrumental colour properties

The instrumental colour properties of goat meat nuggets incorporated with different levels of combination of liver and kidney at 1:1 ratio is presented in Table 4. There was no significant difference noticed in the Lightness (L*), yellowness (a*), redness (b*), hue and chroma values of the control and different treatment groups. The values of all the nuggets were in the range of 45, 14, 9, 32 and 17 for lightness, yellowness, redness, hue and chroma. This indicates that incorporation of raw liver and kidney up to 3.5% in goat meat nuggets had no influence on the L*, a*, b*, hue and chroma value of the goat meat nuggets. Dissimilar findings of higher intensities of redness, decrease in intensity of lightness values were reported by Amaral *et al.,* (2013) and Dalmas *et al.,* (2011), this might be due to the inclusion of blood in the formulations of in goat liver and sheep liver patties.

Texture profile properties

Texture profile properties of goat meat nuggets incorporated with different levels of combination of liver and kidney at 1:1 ratio is presented in Table 5. There was no significant difference noticed in the hardness, adhesiveness, springiness, cohesiveness, gumminess and chewiness values of control nuggets and treatment groups. This may be due to addition of liver and kidney up to 3.5 % in goat meat nuggets had not affected the friction or binding properties of meat particles. The findings of the present study disagreed with Verma *et al.,* (2008) and Devatkal *et al.,* (2004) who found decrease in the hardness, springiness, gumminess and chewiness properties of meat patties prepared with cooked buffalo head and heart meat and liver meat loves respectively when incorporated more than 10%. This may be due to reduction of friction and binding properties among the meat particle and hence reduces the hardness.

Sensory properties

Sensory attributes of goat meat nuggets incorporated with different levels of combination of liver and kidney at 1:1 ratio is presented in Table 6.There was no significant difference was observed between the control and treatment groups up to 3.5 % for the different sensory attributes. However marginal increase in the colour and appearance and flavour scores of goat meat nuggets, as the level of liver and kidney increased but not significantly. The findings of the present study indicated that liver and kidney can be effectively utilized in goat meat nuggets without affecting much of the sensory attributes.

Microbial quality

Microbial quality of goat meat nuggets incorporated with different levels of combination of liver and kidney at 1:1 ratio is presented in Table 7. The range of total plate count (3.81 – 3.99 $\log_{10}$ cfu/gm) and yeast and mould count (2.77 – 2.81 $\log_{10}$cfu/gm) observed in the present study were lower than the prescribed limitations recommended by FSSAI (2011) for meat and meat products and characterizes that the goat meat nuggets was suitable for human consumption. Further, Amaral *et al.,* (2013) reported that the microbial safety of the meat product can be achieved through the application of good manufacturing practices, usage of good quality raw materials and hygienic processing condition.

Table 1: Proximate composition and microbial qualities of edible byproducts like liver and kidney (Mean ± SE value).

S. No.	Parameters	Edible Byproducts		T value
		Kidney	Liver	
1.	Moisture (%)	79.67 ± 0.09	70.76 ± 0.18	42.89**
2.	Protein (%)	15.95 ± 0.08	18.78 ± 0.14	16.76**
3.	Fat (%)	1.80± 0.02	7.63 ± 0.07	73.16**
4.	Ash (%)	1.30 ± 0.03	1.42 ± 0.02	3.06**
5.	Carbohydrate (%)	1.26 ± 0.08	1.38 ±0.19	0.572^{NS}
6.	Moisture protein ratio	4.99 ± 0.03	3.76 ± 0.02	28.68**
7.	Energy K/Cal	80.40 ± 0.21	144.24 ± 0.30	170.12**
8.	Total plate count (log_{10}cfu/gm)	4.48 ± 0.10	4.47 ± 0.10	0.08^{NS}
9.	Yeast and Mould count (log_{10}cfu/gm)	2.73 ± 0.06	2.91 ± 0.13	2.15^{NS}
10.	Coliform count (log_{10}cfu/gm)	1.96 ± 0.18	1.37± 0.24	0.72^{NS}

n = 9, Mean bearing different superscripts differ significantly.

*= significant (P< 0.05), ** = highly significant (P<0.01), NS = Non significant (P>0.05).

Table 2: Formulations for the liver and kidney incorporated goat meat nuggets.

S. No.	Ingredients	Control	Different levels of liver and kidney (%)			
			2.0	2.5	3.0	3.5
1.	Minced goat meat	68.0	66.0	65.5	65.0	64.5
2.	Raw Liver and Kidney – (1:1)	0.0	2.0	2.5	3.0	3.5
3.	Salt	1.5	1.5	1.5	1.5	1.5
4.	Sodium tripolyphosphate	0.5	0.5	0.5	0.5	0.5
5.	Sodium nitrite	0.015	0.015	0.015	0.015	0.015
6.	Sucrose	0.3	0.3	0.3	0.3	0.3
7.	Ice	9.0	9.0	9.0	9.0	9.0
8.	Whole chicken Egg	3.0	3.0	3.0	3.0	3.0
9.	Refined sunflower oil	10.0	10.0	10.0	10.0	10.0
10.	Condiments	3.0	3.0	3.0	3.0	3.0
11.	Maida	3.0	3.0	3.0	3.0	3.0
12.	Dried spice mix	1.7	1.7	1.7	1.7	1.7

Table 3: Effect of different levels of liver and kidney (1:1) on the physicochemical properties of goat meat nuggets (Mean ± SE value).

SL.No.	Parameters	Control	Liver and Kidney (%)				F value
			2.0	2.5	3.0	3.5	
1.	Emulsion stability (%)	95.66 ± 0.14	96.03 ± 0.28	96.13 ± 0.24	96.23 ± 0.29	95.72 ± 0.28	1.00^{NS}
2.	Emulsion pH	6.34 ± 0.01	6.35 ± 0.006	6.35 ± 0.01	6.36 ± 0.01	6.37 ± 0.02	0.42^{NS}
3.	Cooking yield (%)	98.28 ± 0.27	98.36 ± 0.50	97.80 ±0.54	97.98 ± 0.38	97.75 ± 0.38	0.40^{NS}
4.	Product pH	6.44 ± 0.00	6.44 ± 0.00	6.43 ± 0.01	6.43 ± 0.00	6.44 ± 0.00	1.94^{NS}
5.	Moisture (%)	65.82 ± 0.35^{a}	65.91 ± 0.38^{ab}	66.42 ± 0.22^{abc}	66.86 ± 0.34^{bc}	67.32 ± 0.32^{c}	3.68*
6.	Protein (%)	14.20 ± 0.17^{b}	14.11 ± 0.13^{b}	13.91 ± 0.18^{ab}	13.53 ± 0.22^{a}	13.41 ± 0.18^{a}	3.67*
7.	Fat (%)	13.15 ± 0.08	13.32 ± 0.11	13.34 ± 0.09	13.39 ± 0.11	13.49 ± 0.12	1.44^{NS}
8.	Ash (%)	2.79 ± 0.01	2.78 ± 0.06	2.76 ± 0.05	2.82 ± 0.02	2.80 ± 0.03	0.39^{NS}
9.	Carbohydrate (%)	4.01± 0.42	3.86 ± 0.53	3.55 ± 0.33	3.37 ± 0.35	2.95 ± 0.44	0.97^{NS}
10.	Moisture protein ratio	$4.63^{a} \pm 0.05$	$4.67^{a}\pm 0.04$	$4.78^{ab} \pm 0.63$	$4.95^{bc} \pm 0.08$	$5.02^{c}\pm 0.06$	6.73**
11.	Energy K/Cal	191.01±1.65	191.62 ±1.42	189.83 ± 0.81	187.99± 1.49	186.85± 0.66	2.03^{NS}

n = 9, Mean bearing different superscripts differ significantly.

*= significant (P< 0.05), ** = highly significant (P<0.01), NS = Non significant (P>0.05).

Table 4: Effect of different levels of liver and kidney (1:1) on the hunter color properties of goat meat nuggets (Mean ± SE value).

SL.No.	Parameters	Control	Liver and Kidney (%)				F value
			2.0	2.5	3.0	3.5	
1.	Lightness (L*)	45.13 ± 0.29	45.90 ± 0.16	45.87 ± 0.25	45.57 ± 0.30	45.87 ± 0.84	1.62^{NS}
2.	Yellowness (a*)	14.71 ± 0.16	14.66 ± 0.17	14.40 ±0.33	14.21 ± 0.21	14.56 ± 0.33	0.63^{NS}
3.	Redness (b*)	9.28 ± 0.28	9.40 ± 0.11	9.46 ± 0.11	9.36 ± 0.13	9.56 ± 0.13	1.07^{NS}
4.	Hue	32.27 ± 0.27	32.69 ± 0.32	33.38 ± 0.40	33.40 ± 0.39	33.45 ± 0.61	1.60^{NS}
5.	Chroma	17.40 ± 0.16	17.42 ± 0.18	17.24 ± 0.32	17.02 ± 0.20	17.45 ± 0.10	0.51^{NS}

n = 12, NS = Non significant (P>0.05)

Table 5: Effect of different levels of liver and kidney (1:1) on the texture profile properties of goat meat nuggets (Mean ± SE value).

SL.No.	Parameters	Control	Liver and Kidney (%)				F value
			2.0	2.5	3.0	3.5	
1.	Hardness (N)	36.30 ± 0.69	36.03 ± 0.60	35.89 ± 0.38	34.66 ± 0.69	34.74 ± 0.52	1.67^{NS}
2.	Adhesiveness	-0.81 ± 0.59	-0.095 ± 0.06	-0.28 ± 0.16	-0.07 ± 0.01	-0.30 ± 0.08	1.57^{NS}
3.	Springiness (cm)	0.84 ± 0.09	0.84 ± 0.03	0.81 ± 0.06	0.80 ± 0.01	0.80 ± 0.03	0.09^{NS}
4.	Cohesiveness (ratio)	0.38 ± 0.01	0.37 ± 0.03	0.37 ± 0.01	0.35 ± 0.03	0.36 ± 0.04	0.18^{NS}
5.	Gumminess (N)	13.77 ± 0.53	13.41 ± 0.96	13.43 ± 0.36	12.03 ± 1.08	12.39 ± 1.45	0.60^{NS}
6.	Chewiness (N cm)	11.49 ± 1.28	11.24 ± 0.80	11.01 ± 1.04	9.78 ± 1.00	10.10 ± 1.42	0.43^{NS}

n = 6,NS = Non significant (P>0.05).

Table 6: Effect of different levels of liver and kidney (1:1) on the sensory qualities of goat meat nuggets (Mean ± SE value).

SL.No.	Parameters	Control	Liver and Kidney (%)				F value
			2.0	2.5	3.0	3.5	
1.	Color and appearance	7.10 ± 0.16	7.18 ± 0.18	7.21 ± 0.18	7.22 ± 0.16	7.27 ± 0.16	0.12^{NS}
2.	Flavor	7.22 ± 0.18	7.27 ± 0.16	7.31 ± 0.12	7.33 ± 0.16	7.43 ± 0.15	0.25^{NS}
3.	Texture	7.43 ± 0.19	7.40 ± 0.10	7.31 ± 0.10	7.31 ± 0.19	7.21 ± 0.17	0.30^{NS}
4.	Juiciness	7.38 ± 0.15	7.31 ± 0.17	7.27 ± 0.15	7.22 ± 0.15	7.18 ± 0.17	0.22^{NS}
5.	Over all acceptability	7.41 ± 0.11	7.33 ± 0.17	7.32 ± 0.14	7.26 ± 0.19	7.22 ± 0.14	$0.20S^{NS}$

n = 12,NS = Non significant (P>0.05).

Table 7: Effect of different levels of liver and kidney (1:1) on the microbial qualities (log_{10}cfu/gm)of goat meat nuggets (Mean ± SE value).

SL.No.	Parameters	Control	Liver and Kidney (%)				F value
			2.0	2.5	3.0	3.5	
1.	Total plate count	3.81 ± 0.10	3.72 ± 0.83	3.70 ± 0.14	3.89 ± 0.03	3.99 ± 0.83	1.55^{NS}
2.	Yeast and Mould count	2.77 ± 0.08	2.82 ± 0.97	2.78 ± 0.04	2.81 ± 0.09	2.80 ± 0.06	0.09^{NS}
3.	Coliform count	Nil	Nil	Nil	Nil	Nil	

n = 6, NS = Non significant (P>0.05).

Conclusion

Almost all the physicochemical, instrumental colour, texture profile properties and sensory qualities of the combination of liver and kidney incorporated goat were almost similar to the properties of lean meat nuggets. Also, among the treatment groups upto 3.5 % of the treated goat meat nuggets was found desirable by sensory scores and was comparable to the control nuggets. Considering the current demand for the use of by products and to lower the cost of the raw materials, the use of by products like liver and kidney were found more suitable value addition, especially due to its nutritional property and sensory acceptance when incorporated in product. This in turn will fetches more income to the producers and had the advantages of promoting the agribusiness development in the areas were goat by products market values are comparatively lower than meat values.

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