

*Original Research***Development and Quality Evaluation of Ready to Fry Seasoning Meat Pellets****M. Anna Anandh***

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Abstract

Meat based ready to fry seasoning pellets with 20, 30 and 40 % goat meat emulsion were developed and their quality were evaluated. The corresponding levels of rice flour were 80%, 70% and 60% in the respective formulations. Control ready to fry seasoning pellets contained 100% rice flour and no goat meat emulsion. Linear and significantly ($P < 0.05$) increased values were observed from control to goat meat incorporated ready to fry seasoning pellets for pH, product yield, bulk density, moisture, protein and fat contents. Significantly ($P < 0.05$) reverse trends were observed for hydratability, water absorption index and water solubility index. Results of sensory evaluation on 9 - point hedonic scale showed appearance and colour, flavour, texture, crispness, after taste, meat flavour intensity and overall palatability were higher for 30% goat meat emulsion incorporated ready to fry seasoning pellets followed by 40% and 20% goat meat emulsion incorporated ready to fry seasoning pellets. Thus, it can be concluded that, 30% goat meat emulsion can be successfully used preparation of meat based ready to fry seasoning pellets.

Key words: Acceptability, Emulsion, Goat, Meat, Pellets, Quality, Ready to Fry

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Introduction

Ready to fry snack foods like vadam or vathals are the ancient specialties of South India. They are deep fried and served as an accompaniment along with rice and rasam or sambar in South India. Consumer acceptance of ready to fry foods mainly due to convenience, value, attractive appearance, and texture found to be particular for these foods, especially when it concern to snack products. Most of the ready to fry pellets available in the market are mainly based of cereals which are high in calorie and low in protein contents. Incorporation of animal proteins in such snack type food products can improve the nutritional quality especially with respect to amino acid composition, flavor, odor and taste (Kumar *et al.*, 2016). Incorporation of meat in these type products is a good alteration in its nutritional value particularly high value animal

protein (Anna Anandh *et al.*, 2005; Singh *et al.*, 2011). Meat homogenate / fine chopped meat are prepared by mixing or chopping with salt and phosphate. Fine chopped meat contains high levels of extracted myofibrillar proteins that will act as effective binder of water, fat and meat particles. Hence, a scientific approach was made to develop meat based ready to fry seasoning pellets with different level of goat meat emulsion.

Materials and Methods

Goat Meat

Deboned goat meat from indigenous goat breed was purchased from the local meat stall. It was cut into small chunks of about 5 cm x 5 cm size and frozen for 1-2 h to ensure easy mincing. The chevon chunks were minced twice through the meat mincer by using a kidney plate (0.95 cm diameter) and the minced meat was used in the preparation of meat based ready to fry seasoning pellets.

Preparation of Goat Meat Emulsion

Salt (1.5%) and sodium tri polyphosphate (0.5%) were added to the minced goat meat. The materials were chopped for about 2 min with a bowl chopper (Scharffen, Germany). After addition of ice flakes it was chopped again for 1–2 min. Refined vegetable oil (3.0%) was added slowly and chopping was continued till the oil was completely dispersed in the batter. Chopping continued for another 2 min to give a fine viscous emulsion.

Formulation and Treatments

The formula for meat based ready to fry seasoning pellets was developed after conducting a series of preliminary trails. The basic product formulation consists of rice flour, common salt, green chili paste, onion paste, cumin powder, spice mix, asafetida powder and curd. Meat based ready to fry seasoning pellets prepared with incorporation of 20 % (T1), 30 % (T2) and 40 % (T3) goat meat emulsion.

Table 1: Formulation of ready to fry seasoning meat pellets

Ingredients	Control (%)	Level of Goat Meat Emulsion (%)		
		20 (T 1)	30 (T 2)	40 (T3)
Rice flour	100	80	70	60
Common salt	2.5	2.5	2.5	2.5
Green chili paste	1	1	1	1
Cumin powder	0.5	0.5	0.5	0.5
Asafetida powder	0.5	0.5	0.5	0.5
Onion paste	20	20	20	20
Spice mix	1.5	1.5	1.5	1.5
Curd	25	25	25	25

Water: 50% of the rice flour (on weight basis)

The corresponding levels of rice flour were 80% (T1), 70% (T2) and 60% (T3) in the respective formulations. Other ingredients used in the formulation i.e. common salt, green chili paste, onion paste, cumin powder, spice mix, asafetida powder and curd were added over and above rice flour and goat meat emulsion combination. Control ready to fry seasoning pellets contained 100% rice flour (Table 1).

Preparation of Ready to Fry Seasoning Meat Pellets

Required quantity of water (50% of the flour used) boiled at boiling temperature and rice flour slowly added to boiling water and blended continuously and mixed thoroughly to form slurry without lumps in low flame. Then green chili paste, onion paste, cumin powder, spice mixture and asafetida powder were added in dough and mix well. Followed by addition of goat meat emulsion in to the dough and cooked for 10 min and then cover and cool the dough. After cooling, curd was added and kneads it to soft dough. The dough was extruded through a manually operated stainless steel extruder into ribbon shape pellets. The pellets were dried in a hot air oven at $80 \pm 2^\circ\text{C}$ for 5 h to drain out the moisture content completely. The dried ready to fry seasoning pellets was deep oil fried for about 30 sec at $150 \pm 2^\circ\text{C}$. The fried pellets were served immediately to a panel for evaluation of various sensory attributes on a 9 – point hedonic scale.

Physico - Chemical Analysis

Proximate Analysis

The moisture, protein and fat contents of control and goat meat emulsion incorporated ready to fry seasoning pellets were determined by standard methods using hot air oven, kjeldahl's assembly and soxhlet ether extraction apparatus, respectively (AOAC, 1995).

pH

The pH of control and goat meat emulsion incorporated ready to fry seasoning pellets were determined by using digital pH meter. Homogenates were prepared by blending 10 g sample with 90 ml distilled water using a tissue homogenizer for 1 min. The pH of the homogenates was recorded by immersing combined glass electrode of digital pH meter (Century Instruments Ltd, India) as described by Mittal and Lawrie (1986).

Product Yield

The weight of control and goat meat emulsion incorporated ready to fry seasoning pellets were recorded before drying and after frying and the yield was calculated (product yield = weight of dried products / weight of raw products $\times 100$) and expressed as percentage.

Bulk Density

Bulk density of control and goat meat emulsion incorporated ready to fry seasoning pellets were determined based on the procedure of described by Mittal and Lawrie (1986). Pieces of extrudates were assumed to be

cylindrical in shape and the volume was calculated using the formula of πr^2 ($\pi \times \text{radius}^2 \times \text{length}$). The extrudate of known length was weighed and bulk density was calculated as mass / volume ($\text{g} / \text{cm}^{-3}$).

Hydratability

Hydratability of control and goat meat emulsion incorporated ready to fry seasoning pellets were determined based on the procedure of Mittal and Lawrie (1986). Weighed pieces of products (approximately 2.5 g) were placed in test tubes with excess boiling water for 5 min to hydrate the sample. The hydrated samples were drained for 5 min, blotted and weighed. Hydratability of control and goat meat emulsion incorporated ready to fry seasoning pellets were estimated as weight of water absorbed / weight of dry sample (g/g).

Water Absorption Index: Water absorption index was measured according to the method described by Anderson *et al.* (1969). 2.5 g of ground sample was weighed in 100 ml centrifuge tubes, 30 ml of distilled water was added and the sample was left equilibrated for 30 min with occasional stirring. After centrifugation at 3000 rpm for 10 min, the supernatant was carefully poured into the Petri dish and the remaining gel was weighed. The water absorption index calculated as the ratio of gel obtained to that of initial weight of sample (g/g).

Water Solubility Index

The water solubility index was measured according to the method described by Machado *et al.* (1998). The supernatant liquid obtained from water absorption index determination was used for determination of water solubility index. The supernatant liquid was kept in hot air oven to evaporate to dryness. After drying, the petridishes were cooled and weighed. The water solubility index was calculated as weight of solids to the initial weight of the sample (g/g).

Sensory Evaluation

Sensory evaluation was conducted with semi-trained panelists. Control and goat meat emulsion incorporated ready to fry seasoning pellets were served to the panelists after deep oil fried for about 30 seconds at $150 \pm 1^\circ\text{C}$. The sensory attributes like appearance and colour, flavour, texture, crispness, after taste, meat flavour intensity and overall palatability were evaluated on 9 - point descriptive scale (where in 1 is extremely undesirable and 9 is extremely desirable) as suggested by Keeton (1983).

Statistical Analysis

The experiment was repeated four times. The data generated from each trial were analyzed statistically by following standard procedures (Snedecor and Cochran, 1989) for comparing the means and to determine the effect of treatment.

Results and Discussion

Physico - Chemical Characteristics of Ready to Fry Seasoning Meat Pellets

Results of physico – chemical characteristics of control and goat meat emulsion incorporated ready to fry seasoning pellets are presented in Table 2.

Table 2: Effect of goat meat emulsion on physico-chemical characteristics of meat based ready to fry seasoning pellets (Mean \pm SE)

Physico - Chemical Parameters*	Control	Level of Goat Meat Emulsion (%)		
		20 (T 1)	30 (T 2)	40 (T3)
pH	6.20 \pm 0.10 ^a	6.35 \pm 0.12 ^b	6.50 \pm 0.08 ^c	6.60 \pm 0.10 ^d
Product yield (%)	50.38 \pm 0.12 ^a	58.10 \pm 0.14	66.50 \pm 0.12 ^c	74.10 \pm 0.10 ^d
Bulk density (g / cm-3)	2.44 \pm 0.10 ^a	2.68 \pm 0.14 ^b	3.10 \pm 0.12 ^c	3.90 \pm 0.12 ^d
Hydratability (g / g)	2.75 \pm 0.14 ^a	2.54 \pm 0.12 ^b	1.50 \pm 0.10 ^c	1.08 \pm 0.14 ^d
Water absorption index (g / g)	6.88 \pm 0.10 ^a	5.80 \pm 0.12 ^b	4.20 \pm 0.12 ^c	3.42 \pm 0.14 ^d
Water solubility index (g / g)	1.62 \pm 0.14 ^a	1.10 \pm 0.12 ^b	0.70 \pm 0.10 ^c	0.48 \pm 0.10 ^d
Moisture (%)	4.30 \pm 0.12 ^a	4.98 \pm 0.12 ^b	5.80 \pm 0.12 ^c	6.54 \pm 0.10 ^d
Protein (%)	9.38 \pm 0.12 ^a	12.10 \pm 0.12 ^b	14.02 \pm 0.10 ^c	15.67 \pm 0.14 ^c
Fat (%)	1.92 \pm 0.12 ^a	4.42 \pm 0.10 ^b	5.88 \pm 0.12 ^c	6.76 \pm 0.10 ^c

Number of observations: *= 4; Means bearing same superscripts row- wise do not differ significantly (P<0.05).

The values for pH progressively and significantly (P<0.05) increased from control to treatments. Significantly (P<0.05) higher pH value was observed in 40% goat meat emulsion incorporated ready to fry seasoning pellets followed by 30% and 20% goat meat incorporated ready to fry seasoning pellets and control. It might be due to higher protein contents of goat meat emulsion incorporated ready to fry seasoning pellets. The mean \pm SE product yield increased significantly from control to goat meat emulsion incorporated ready to fry seasoning pellets. Among goat meat emulsion incorporated ready to fry seasoning pellets, higher product yield observed in 40% goat meat emulsion incorporated ready to fry seasoning pellets followed by 30% and 20% goat meat emulsion incorporated ready to fry seasoning pellets. Addition of goat meat emulsion increased protein availability which results in greater solubilization of muscle proteins during emulsification process and thus leads to increased product yield in meat emulsion incorporated ready to fry seasoning pellets as compared to control. The mean \pm SE bulk density values of control and goat meat emulsion incorporated ready to fry seasoning pellets differ significantly (P<0.05) between them and the value were significantly (P<0.05) increasing with increasing level of goat meat emulsion in the formulation. Among goat meat emulsion incorporated ready to fry seasoning pellets, bulk density value was higher in 40% goat meat emulsion incorporated ready to fry seasoning pellets followed by 30% and 20% goat meat emulsion incorporated ready to fry seasoning pellets and control. Increased moisture content of extrudate contributed to increased bulk density (Barrett and Ross, 1990; Kavya Reddy *et al.*, 2014). Breen *et al.* (1977) reported that combination of high concentration of starch, high protein and high fiber snack foods tend to decreased the bulk density.

The present findings are in agreement with the above findings. The mean \pm SE value of hydratability values decreased significantly ($P < 0.05$) from control to goat meat emulsion incorporated ready to fry seasoning pellets. Among goat meat emulsion ready to fry seasoning pellets, higher hydratability value observed in 20% goat meat emulsion incorporated ready to fry seasoning pellets followed by 30% and 40% goat meat emulsion incorporated ready to fry seasoning pellets. These finding are in conformity with those of Mittal and Lawrie (1984) who reported that presence of meat in extrudates lowered the ability of hydrate the products. The mean \pm SE water absorption index value was significantly ($P < 0.05$) higher in control as compared goat meat emulsion incorporated ready to fry seasoning pellets. Among goat meat emulsion incorporated ready to fry seasoning pellets, higher water absorption index value observed in 20% goat meat emulsion incorporated ready to fry seasoning pellets followed by 30% and 40% goat meat emulsion incorporated ready to fry seasoning pellets and the value differ significantly between them. This is in agreement with findings of Davidson *et al.* (1984) and Cheftel (1986). They reported that when starch was used in large quantity, water absorption index of extrudates increased due to increased starch gelatinization. Park *et al.* (1993) also reported that high starch and low fat level resulted in higher water absorption index of products. The mean \pm SE water solubility index value was significantly ($P < 0.05$) decreased from control to goat meat emulsion incorporated ready to fry seasoning pellets. Higher water solubility index value was observed in control followed by 20%, 30% and 40% goat meat emulsion incorporated ready to fry seasoning pellets. Water solubility index of control and goat meat emulsion incorporated ready to fry seasoning pellets differed significantly ($P < 0.05$) between them. The higher water solubility index of control as compared to goat meat emulsion incorporated ready to fry seasoning pellets could be attributed to higher level of starch with increased fragmentation and starch conversion resulting in higher water solubility characteristics (Gomez and Aguilera, 1983; Wen *et al.*, 1990; Siriburi and Hill, 2000). The results of this present study are also in conformity with above findings.

The mean \pm SE moisture, protein and fat contents of goat meat emulsion incorporated ready to fry seasoning pellets significantly ($P < 0.05$) higher as compared to control. Mean moisture contents progressively and significantly ($P < 0.05$) increased from control to treatments. Significantly ($P < 0.01$) lower moisture contents observed in control as compared to goat meat emulsion incorporated ready to fry seasoning pellets. Jean *et al.* (1996) reported that snack foods should have moisture content of less than 5% to make the product brittle. Though the goat meat emulsion incorporated ready to fry seasoning pellets of this study showed slightly higher moisture content. The mean protein and fat contents also significantly ($P < 0.05$) increased from control to goat meat emulsion incorporated ready to fry seasoning pellets. The mean protein and fat contents of 30% and 40% goat meat emulsion incorporated ready to fry seasoning pellets did not differ significantly between them but differ significantly ($P < 0.05$) from 20% goat meat emulsion incorporated ready to fry seasoning pellets and control. The results are in agreement with the findings of Singh *et al.*

(2014) who reported increased protein, fat and ash contents in dried snack food products with increasing levels of incorporation of meat. Similar findings are also reported by Jean *et al.* (1996); Rhee *et al.* (1999); Singh *et al.* (2002).

Effect of Different Levels of Goat Meat Emulsion on Sensory Characteristics of Meat Based Ready to Fry Seasoning Pellets

Results of sensory evaluation of control and goat meat emulsion incorporated ready to fry seasoning pellets are presented in Table 3. There was significant ($P < 0.05$) improvement in appearance scores in all goat meat emulsion incorporated meat based ready to fry seasoning pellets as compared to control. Although, appearance and colour scores for 30% goat meat emulsion incorporated chicken meat based ready to fry seasoning pellets were higher as compared to 20% and 40% goat meat emulsion incorporated ready to fry seasoning pellets. The difference in appearance and color scores between 20% and 30% meat incorporated ready to fry seasoning pellets did not differ significantly between them. Appearance and colour scores between control and 40% goat meat emulsion incorporated ready to fry seasoning pellets were also non-significant. The mean \pm SE flavor scores were significantly ($P < 0.05$) higher in 30% goat meat emulsion incorporated ready to fry seasoning pellets followed by 40%, 20% goat meat incorporated ready to fry seasoning pellets and control. The flavour score of between control, 20% and 40% goat meat emulsion incorporated ready to fry seasoning pellets did not differ significantly between them but differ significantly from 30% goat meat emulsion incorporated ready to fry seasoning pellets. The mean \pm SE texture scores were significantly ($P < 0.05$) decreased as increasing level of goat meat emulsion in the formulation.

Table 3: Effect of goat meat emulsion on sensory attributes of meat based ready to fry seasoning pellets (Mean \pm SE)

Sensory Attributes**	Control	Level of Goat Meat Emulsion (%)		
		20 (T 1)	30 (T 2)	40 (T3)
Appearance & colour	6.60 \pm 0.12 ^a	7.80 \pm 0.10 ^b	7.90 \pm 0.10 ^b	6.60 \pm 0.10 ^a
Flavour	6.50 \pm 0.10 ^a	6.50 \pm 0.10 ^a	8.20 \pm 0.12 ^b	6.50 \pm 0.10 ^a
Texture	7.00 \pm 0.14 ^a	6.90 \pm 0.14 ^b	6.90 \pm 0.12 ^b	6.80 \pm 0.12 ^b
Crispiness	8.10 \pm 0.12 ^a	7.20 \pm 0.10 ^b	7.10 \pm 0.10 ^b	6.50 \pm 0.12 ^c
Aftertaste	6.60 \pm 0.10 ^a	6.70 \pm 0.10 ^a	7.60 \pm 0.12 ^b	6.70 \pm 0.10 ^c
Meat flavour intensity	-	6.30 \pm 0.14 ^a	7.30 \pm 0.10 ^b	7.40 \pm 0.10 ^b
Overall acceptability	6.96 \pm 0.12 ^a	6.90 \pm 0.10 ^a	7.50 \pm 0.11 ^b	6.75 \pm 0.10 ^a

Number of observations: ** = 32; Sensory attributes were evaluated on a 9 – point descriptive scale (wherein 1 = extremely undesirable; 9 = extremely desirable); Means bearing same superscripts row- wise do not differ significantly ($P < 0.05$).

Mean texture scores significantly ($P < 0.05$) higher for control as compared to goat meat emulsion incorporated ready to fry seasoning pellets. Texture scores between goat meat emulsions incorporated ready to fry seasoning pellets did not differ significantly between them but differ significantly from control. The mean \pm SE crispiness scores also significantly ($P < 0.05$) decreased with increasing level of goat meat

emulsion in the ready to fry seasoning pellets. Crispiness scores were significantly ($P < 0.05$) lower in 40 % goat meat emulsion incorporated ready to fry seasoning pellets. Crispiness scores between 20% and 30% goat meat emulsion incorporated ready to fry seasoning pellets did not differ significantly between them but differ significantly from control and 40% goat meat emulsion incorporated ready to fry seasoning pellets. The mean \pm SE after taste scores were significantly ($P < 0.05$) higher for 30% goat meat emulsion incorporated ready to fry seasoning pellets as compared to other goat meat emulsion incorporated ready to fry seasoning pellets and control. Significantly ($P < 0.05$) higher meat flavour intensity scores were observed in 40% goat meat emulsion incorporated ready to fry seasoning pellets followed 30% and 20% goat meat emulsion incorporated ready to fry seasoning pellets. However, meat flavor intensity scores between 40% and 30% goat meat emulsion incorporated ready to fry seasoning pellets did not differ significantly between them but differ significantly ($P < 0.05$) from 20% goat meat emulsion incorporated ready to fry seasoning pellets. Significantly ($P < 0.05$) higher overall acceptability scores observed in 30% goat meat emulsion incorporated ready to fry seasoning pellets as compared to other goat meat emulsion incorporated ready to fry seasoning pellets and control. Overall acceptability scores between control, 20% and 40% goat meat emulsion incorporated ready to fry seasoning pellets did not differ significantly between them.

Conclusion

Goat meat emulsion incorporated meat based ready to fry seasoning pellets had better physico – chemical characteristics and were rated moderately to very palatable whereas control ready to fry seasoning pellets were rated moderately palatable. However, the overall acceptability scores were higher for 30% goat meat emulsion incorporated meat based ready to fry seasoning pellets followed by 20 % goat meat emulsion incorporated meat based ready to fry seasoning pellets, control and 40 % goat meat emulsion incorporated meat based ready to fry seasoning pellets. Finding of this study has shown that 30% goat meat emulsion can be effectively used for preparation of meat based ready to fry seasoning pellets of an acceptable quality with improved nutritional value.

References

1. Anderson, R.A., Coonway, B.H.F., Pfrifer, V. F. and Griffin, E. J. Jr. 1969. Gelatinization of corn grits by roll and extrusion cooking. *Cereal Science Today*, 14:4-12.
2. Anna Anandh, M., Lakshmanan, V., Mendiratta, S.K., Anjaneyulu, A.S.R. and Bisht, G.S.2005. Development and quality characteristics of extruded tripe snack from buffalo rumen meat and corn flour. *Journal of Food Science and Technology*, 42:263–267
3. AOAC. 1995. Official Methods of Analysis, 16th ed., Association of Official Analytical Chemists, Washington DC, USA.
4. Barrett, A.H. and Ross, E. 1990. Correlation of extrudates infusibility with bulk properties using image analysis. *Journal of Food Science*, 55:1378-1382.
5. Breen, M.D., Seyam, A. A. and Banasik, O. J. 1977. The effect of mill by product and soy protein on the physical characteristics of expanded snack foods. *Cereal Chemistry*, 54:728-736.

6. Cheftel, J.C. 1986. Nutritional effects of extrusion cooking. *Food Chemistry*, 20: 263-283.
7. Davidson, V.J., Paton, D., Biosady, L.L. and Rubin, L.R. 1984. A model for mechanical degradation of wheat starch in a single screw extruder. *Journal of Food Science*, 49:1154-1157.
8. Gomez, M.H. and Aguilera, J.M. 1983. A physico chemical model for extrusion of corn starch. *Journal of Food Science*, 49:43, 63.
9. Jean, I.J., Work, R., Camire, M.E., Briggs, J., Barrett, A.H. and Bushway, A.A. 1996. Selected properties of extruded potato and chicken meat. *Journal of Food Science*, 61:783-789.
10. Kavya Reddy, M., Aparna Kuna, Lakshmi Dev, N., Krishnaiah, N., Charanjit Kaur, and Nagamalleswari, Y. 2014. Development of extruded Ready-To-Eat (RTE) snacks using corn, black gram, roots and tuber flour blends. *Journal of Food Science and Technology*, 51:1929-1937.
11. Keeton, J.T. 1983. Effect of fat and NaCl / Phosphate levels on the chemical and sensory properties of pork patties. *Journal of Food Science*, 48: 878 – 881.
12. Kumar, P., Chatli, M.K., Metha, N., Malve, O.P., Verma, A.K. and Kumar, D. 2016. Quality attributes and storage stability of chicken meat biscuits incorporated with wheat and oat bran. *Journal of Food Quality*, 39: 649-657.
13. Machado, M.F., Oliveria, F.A.R., Gekas, V. and Singh, R.P. 1998. Kinetics of moisture uptake and soluble solids loss by puffed breakfast cereals immersed in water. *International Journal of Food Science and Technology*, 33:225-237.
14. Mittal, P. and Lawrie, R.A. 1984. Extrusion studies of mixture containing certain meat offals. Part 1. Objective properties. *Meat Science*, 10:101-116.
15. Mittal, P. and Lawrie, R.A. 1986. Extrusion studies of mixture containing certain meat offals. Part 2: Texture properties. *Meat Science*, 16:143-160.
16. Park, J., Rhee, K.S., Kim, B.K. and Rhee, K.C. 1993. High protein texturized products of defatted soy flour, corn starch and beef: Shelf life, physical and sensory properties. *Journal of Food Science*, 58:21-27.
17. Rhee, K.S., Cho, S.H. and Pradahn, A.M. 1999. Composition, storage stability and sensory properties of expanded extrudates from blends of corn starch and goat meat, lamb, mutton, spent fowl meat, or beef. *Meat Science*, 52: 135-141.
18. Singh, P., Sahoo, J., Chatli, M. K. and Biswas, A.K. 2014. Optimization of the level of rice flour in chicken meat caruncles. *Indian Journal of Veterinary Research*, 23:10 – 20.
19. Singh, V.P., Sanyal, M.K., Dubey, P.C. and Mendiratta, S.K. 2011. Quality assessment of vacuum packaged chicken snacks stored at room temperature. *Journal of Storage and Post-Harvest Research*, 2:120-126.
20. Singh, V.P., Dubey, P.C. and Sanyal, M.K. 2002. Quality of chicken snack affected by the level of spent hen meat. *Indian Journal of Poultry Science*, 37:73-77.
21. Snedecor, G.W. and Cochran, W.G. 1989. Statistical Methods. 8th edn., Oxford and IBH Publishing CO., Calcutta.
22. Siriburi, P. and Hill, S.E. 2002. Extrusion of cassava starch with either variations in ascorbic acid concentration or PH. *International Journal of Food Science and Technology*, 35: 141-154.
23. Wen, L.F., Rodies, P. and Wasserman, B.P. 1990. Starch fragmentation and protein insolubilization during twin screw extrusion of corn meal. *Cereal Chemistry*, 67: 268-275.