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Development of Shelf Stable Edible Product from Sheep Rumen

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ABSTRACT

Sheep (*Ovis aries*) belongs to the ruminant classification of animal. Ruminants are characterized by presence of four stomachs *viz.,* rumen, reticulum, omasum and abomasums. Rumen is the largest part of four stomachs of ruminants. Due to rubbery texture rumen is not preferred for consumption by consumers. This work was undertaken to develop a shelf stable value added product named as 'sheep rumen crackle' for profitable utilization of sheep rumen. Steps in production of sheep rumen crackle include collection of sheep rumen, cleaning, cutting, cooking, addition of salt & spices and drying to reach a moisture level of 5.30 ± 0.13 % and a water activity of 0.32 ± 0.01. Levels of salt and spices were standardized at 3.0 % and 1.0 % respectively. Dried rumen flakes are semi convenient products which can be stored at room temperature and can be fried before consumption. Fried products are shelf stable and could be stored by aerobic packaging at room temperature up to one year. No microbial growth including total plate count, coliforms and yeast & mould count were found in the product even after one year storage. Products were highly acceptable by the sensory panel and crispiness of the products enhanced its acceptability. It was concluded that preparation of sheep rumen crackles can be an effective approach for profitable utilization of sheep rumen.

Keywords: *Sheep, byproduct, rumen, dried product, shelf stable, crackles.*

INTRODUCTION

Utilization of animal byproducts is a lifeline for the meat industry. It plays an important role in the economy of the country as well as helps in reducing the price of meat. It also has pivotal role in the prevention of environmental pollution and providing a positive image to the meat sector. Sheep (*Ovis aries*) belongs to the ruminant classification of animal. Ruminants are characterized by their four-chambered stomach and "cud-chewing" behavior (Susan Schoenian, 2012). Three of the four ruminant stomach compartments make up the fore stomach. These three compartments – the rumen, reticulum, and omasum are an extension of the lower oesophagus. These compartments are lined with small fingerlike projections called papillae, which increase the absorptive surface of the rumen. Rumen, the first of the fore stomach chambers, stores and processes plant material (Julio 2007). The rumen occupies large percentage of the abdominal cavity of the sheep. It is a large storage space for food (about 19 to 38 liter) and contains billions of bacteria and other microbes. These microbes produce the enzymes that digest cellulose into sugars and fatty acids for their hosts to use, in which feed is fermented (Simmons and Carol 2001).

After slaughter and dressing of sheep, rumen is not consumed because of its soft and rubbery texture and "visceral-type" flavor (Mittal and Lawrie 1984; Campos and Arêas, 1993), and for cultural reasons. Rumen is also a highly perishable

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product which needs to be stored in low temperature for its preservation. Hence, it is often underutilized and is sold at a very low price.

Like soy proteins, rumen proteins (raw and extruded) have functional properties and nutritive value appropriate for use as food ingredients (Silva et al 2010a; Silva et al 2010b; Vaz and Arêas 2010) and could potentially replace soy proteins in meat products.

However, all attempts had their own limitations for exploitation in commercial application because of the inherent toughness, due to high collagen content and poor keeping quality of rumen meat (Parivell 1999). So far, no suitable and simple method has been developed to utilize rumen in the preparation shelf stable food for consumption. In this perspective, it is necessary to evolve appropriate technology to convert the tough, less palatable and highly perishable rumen into convenient, attractive and more acceptable novel products. The purpose of the present study was to develop and evaluate shelf stable value added product from sheep rumen for its profitable utilization.

MATERIALS AND METHODS:

Collection of raw material Sheep rumen required for the experiments was collected hygienically immediately after slaughter of animals from Municipal slaughterhouse, Chengicherla, Hyderabad. It was packed in low- density polythene (LDPE) bags and brought to the laboratory within 20 minutes. Rumen was washed with hot water (50 - 55^0 C) for 15 - 20 minutes and dark internal lining was scraped and removed. After cleaning with water, rumen was cut into small pieces and divided into four portions of 1 kg each.

Preparation of sheep rumen crackles Cleaned rumen pieces were pressure cooked at 120^0 C for 20 min and later mixed with salt (3 %) and spice powder (1 %). Level of salt and spice mix appropriate for the product was standardized after conducting preliminary trials. Cooked samples were sundried during summer months with approximate outside temperature around 40^0 C with a daily exposure of 7 hr for two days. After complete drying the samples were fried with refined vegetable oil and stored by packaging aerobically in low density polyethylene bags.

Physicochemical and sensory evaluation of sheep rumen crackles The moisture, ash, protein and crude fat (ether extract) of raw and fried rumen flakes were determined in triplicate as per AOAC (1995) protocols. Water activity of the products was measured using water activity meter (Hygrolab, Switzerland). Sensory evaluation of the product was done by using an 8- point descriptive scale wherein score 8 is taken as excellent and score 1 is taken as extremely poor (Keeton, 1983). The sensory panel consisted of eight experienced scientists and research fellows. The panelists were explained about the nature of experiments without disclosing the identity of samples and were asked to rate their preference on an 8 point descriptive scale on the sensory evaluation proforms for different parameters *viz.*, appearances, flavor, spiciness, crispiness, saltiness and overall acceptability.

Storage studies Stability of the product at room temperature were studied by evaluation of samples for total plate count, coliform count and yeast & mold count at 0, 90, 180, 270 and 360 days interval. Sensory evaluation of the products was also done for the product at periodic interval during storage period.

Statistical analysis The experiment was repeated three times and the data were analyzed statistically using SPSS software as per Duncan (1995).

RESULTS AND DISCUSSION

This study presents a method for preparation of shelf stable product from the rumen of sheep, so as to add value to a major byproduct from sheep, in turn providing a means for its better utilization. Series of experiments were conducted and the production was standardized and the standardized product was subjected to physico-chemical and sensory analysis. Microbiological and sensory properties of the aerobically stored products at

room temperature were also analyzed to evaluate the storage stability of the product.

Standardization of preparation method for sheep rumen crackles Rumen is not a preferred part for consumption by consumers due to its toughness consequent to high collagen content. To reduce its toughness and to increase the shelf life drying and frying interventions were adopted. Cutting of rumen to pieces, high temperature cooking, drying and frying reduced the toughness and the final products were crispy and were highly accepted by sensory panelists. Ingredients used for improving sensory acceptability were salt and spice.

Level of salt in the product was standardized by adding salt at different levels. Salt was added at 2, 3 & 4 % of the total weight and was subjected to sensory evaluation. Product prepared without any salt was taken as control. Sensory scores of crackles prepared with different levels of salt are given in table 1. Crackles prepared with 3 % salt showed highest crispiness, saltiness and overall acceptability scores as compared to products prepared with 2 % and 4 % salt. Hence, level of salt required for preparation of acceptable sheep rumen crackles was standardized at 3 % level.

Level of spice was standardized by adding it at 0.5, 1.0 and 1.5 % level in the product prepared with 3 % salt level. Addition of spice gave acceptable reddish color to the crackles. Sensory scores of crackles prepared with different levels of spice is given in table 2. Results revealed that flavor, crispiness, saltiness and overall acceptability of the sheep rumen crackles prepared with 1 % spice were non significantly higher than that of other treatments and control. The 1 % spice level was selected as appropriate for preparation of sheep rumen crackles.

Physicochemical evaluation of sheep rumen crackles The consumer acceptance of byproduct foods varies widely depending upon their social, economical, geographical, political, cultural and ethnic backgrounds (Jimenez-Colmenero et al. 2001).

Visceral mass (including stomach and intestines) forms an important by-product of the meat industry and constitute nearly 4% of the live weight of the

Table 1: Comparison of sensory scores of sheep rumen crackles prepared with different levels of salt (Mean ± SE)*

Treatment	Appearance	Flavour	Spiciness	Crispiness	Saltiness	Overall acceptability
Control (No salt)	6.65±0.21	6.62±0.18	6.73±0.20	6.73±0.22	5.35^{b}±0.48	6.38±0.22
2% Salt	6.81±0.22	7.00±0.19	7.08±0.15	7.04±0.18	6.96^{a}±0.20	6.96±0.19
3% Salt	6.81±0.20	7.00±0.20	7.00±0.16	7.15±0.19	7.19^{a}±0.22	7.08±0.22
4% Salt	6.85±0.23	6.92±0.21	7.00±0.16	7.15±0.19	6.31^{a}±0.36	6.58±0.25
SEM	**0.104**	**0.097**	**0.083**	**0.098**	**0.190**	**0.113**
P Value	**0.93**	**0.46**	**0.49**	**0.38**	**0.001**	**0.103**

* Values with different superscripts in a column vary significantly at p value £ 0.05

Table 2: Comparison of sensory scores of sheep rumen crackles prepared with different levels of spice (Mean ± SE)*

Treatment	Appearance	Flavour	Spiciness	Crispiness	Saltiness	Overall acceptability
Control (No spice)	7.42 ^{a}± 0.14	6.88±0.21	6.36^{b}±0.24	7.29±0.22	6.92±0.18	6.96±0.18
0.5% Spice	7.25^{a}±0.12	7.25±0.17	7.05^{a}±0.20	7.29±0.18	7.13±0.15	7.04±0.14
1% Spice	7.25^{a}±0.17	7.33±0.15	7.36^{a}±0.15	7.46±0.14	7.33±0.13	7.33±0.14
1.5% Spice	6.83^{b}±b0.11	7.29±0.13	7.32^{a}±0.14	7.29±0.18	7.21±0.11	7.04±0.20
SEM	**0.723**	**0.863**	**0.109**	**0.088**	**0.074**	**0.837**
P Value	**0.02**	**0.216**	**0.002**	**0.889**	**0.249**	**0.419**

* Values with different superscripts in a column vary significantly at p value £ 0.05

slaughtered animal (Ranganayaki and Srinivasan 1999). Rumen is not a preferred part for consumption by consumers due to its toughness consequent to high collagen content. Traditionally, meat processing is a means of extending shelf life (preserving) and producing a convenient item for use later and elsewhere (Casey et al. 2003).

Cleaned rumen pieces were cut into pieces and pressure cooked at 120^0 C for 20 min. High temperature cooking helped in degradation of collagen fiber thereby reducing its toughness. Standardized product prepared by addition of 3 % salt and 1 % spice after cooking, drying and frying were subjected to physicochemical evaluation. Fresh rumen sample and dried rumen sample were also analyzed and compared with that of final product. Physicochemical characteristics of fresh rumen, dried rumen flakes and fried crackles are given in table 3. There was significant difference in moisture percentage between fresh rumen (84.1 %) and dried (5.30 %), fried (4.87 %) rumen flakes. Consequent to drying & frying the water activity was significantly higher in fresh rumen (0.945) when compared to dried (0.32) and fried rumen flakes (0.31). The fat content of fried rumen flakes (24.12) is significantly higher due to deep fat frying as compared to fresh (0.29) and dried (3.36) rumen flakes. The protein percentage was significantly higher in dried rumen flakes (72.49) when compared to fresh (11.46) and fried (51.90) rumen flakes. Ruminal non degradable protein values was reported as 49.3%, 49.0%, and 44.0%, reported by Lee et al. (1986) and National Research Council (1989) respectively.

Storage stability of sheep rumen crackles Shelf life and quality of fresh meat are influenced by initial quality, package parameters, and storage conditions (Zhao et al. 1994). Hence, utmost care was taken to clean and process the rumen hygienically avoiding any possible contamination. Colour, microbial growth, lipid oxidation (Esmer et al. 2011), appearance, flavour and texture (Lawrie 1998) are important factors for the shelf life and consumer acceptance of meat products.

Rumen crackles produced were stored at room temperature under aerobic packaging. During storage rumen crackles were analyzed for total

Table 3: Physicochemical characteristics of sheep rumen crackles (Mean ± SE)*

Treatment	Moisture (%)	Protein(%)	Fat(%)	Ash(%)	Water Activity
Fresh sheep rumen	84.10^{a}±0.79	11.46^{c}±0.41	0.29^{b}±0.05	5.66^{b}±0.33	0.945^{a}±0.002
Dried sheep rumen flakes	5.30^{b}±0.13	72.49^{a}±0.60	3.36^{b}±0.09	9.42^{a}±0.84	0.323^{b}±0.014
Sheep rumen crackles (dried & fried)	4.87^{b}±0.54	51.90^{b}±1.37	24.12^{a}±3.32	9.03^{a}±0.77	0.315^{b}±0.015
SEM	**10.54**	**5.57**	**3.51**	**0.569**	**0.118**
P Value	**0.0001**	**0.0001**	**0.0001**	**0.001**	**0.0001**

* Values with different superscripts in a column vary significantly at p value £ 0.05

Table 4: Comparison of sensory scores of sheep rumen crackles during storage period (Mean ± SE)*

Storage Days	Appearance	Flavour	Spiciness	Crispiness	Saltiness	Overall acceptability
0	6.81±0.20	7.00±0.20	7.00±0.16	7.15±0.19	7.19±0.22	7.08^{a}±0.22
90	6.73±0.18	6.88±0.16	6.96±0.16	7.04±0.13	7.08±0.15	7.00^{a}±0.17
180	6.54±0.25	6.73±0.11	6.81±0.15	7.00±0.11	7.00±0.13	6.96^{a}±0.07
270	6.42±0.14	6.65±0.14	6.73±0.12	6.85±0.13	6.88±0.08	6.81^{ab}±0.14
360	6.23±0.12	6.50±0.14	6.65±0.12	6.65±0.12	6.69±0.09	6.46^{b}±0.12
SEM	**0.08**	**0.07**	**0.06**	**0.06**	**0.06**	**0.07**
P Value	**0.17**	**0.14**	**0.38**	**0.09**	**0.06**	**0.02**

* Values with different superscripts in a column vary significantly at p value £ 0.05

plate count, coliform and yeast & mold count. Products were also evaluated for sensory properties. Dried rumen flakes were analyzed at 0, 90, 180, 270 and 360 days of storage. Results of microbiological study revealed that fresh rumen sample had 4.44, 4.04 and 4.35 log units of total plate count, yeast & mold and coliform respectively No microbial growth including total plate count, coliform and yeast & mould count were found in rumen crackles even at one year storage.

Sensory scores of sheep rumen crackles during storage period is given in table 4. There was no significant difference between sensory attributes such as appearance, flavor, spiciness, crispiness, saltiness but overall acceptability during the storage period 360 days Products were microbially and sensorially acceptable even after one year of storage at room temperature.

CONCLUSION

It could be concluded from the study that, production of 'sheep rumen crackles' through simple means of cooking, adding salt and spices, sun drying and frying can be a good approach for effective utilization of sheep rumen and to increase its acceptability among consumers. Product developed had very low water activity enabling its shelf stability up to one year at room temperature.

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