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Process standardization for puffed product from spent hen meat

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Abstract
The availability of culled and spent hens has also increased many folds with rapid development of poultry layer industry. The meat from spent hen is generally tough, less tender which reduces the market value. Better use of this meat could provide economic profits. The present study was aimed to produce a value added Hot Extruded puffed product by incorporation of spent hen meat emulsion in the flour in various proportions. Spent hen meat emulsion and two flour mixtures (Corn flour and Rice flour) were admixed in 15:85 (T_1), 20:80 (T_2) and 25:75 (T_3) proportions to obtained emulsion based dough to produce hot extruded puffed product. Hot extruded puffed products thus obtained by twin screw hot extruder were rich in protein because of incorporation of spent hen meat which possessed almost 10-15% protein. Puffed product from flour mixture admixed with spent hen meat emulsion in different proportion can be effectively manufactured by using twin screw hot extruder.

Keywords: Hot extrusion, puffed product, spent hen, meat emulsion, twin screw extruder

Introduction

Economic development is normally accompanied by improvement in country food supply and gradually eliminates the problem of nutrient deficiency. India is number one in livestock population with poultry population of 613 million. In addition to providing nutritional security to the poor, it offers employment to millions of people in rural areas. In comparison with other livestock sectors, the poultry industry in India is well organized and progressing towards modernization. Today poultry is one of the fastest growing segments of the agricultural sector in India and now the world's third largest egg producer and the fifth largest producer of broilers.

As the egg laying capacity of layer bird is absolute, the farmers have to face a problem discarding spent hen. The disposal of layer hens is one of the main economic and environmental problems of the poultry industry. Egg producer worldwide disposes off 2.6 billion spent hens usually after they have finished their laying cycle (Singh *et al*., 2001). The availability of culled and spent hens has also increased many folds with rapid development of poultry layer industry. Spent hens are those birds of poultry industry whose egg laying capacity is over. The meat from spent hen is generally tough, less tender and poor in functional properties, because of its increased collagen content and cross linkages (Bailey, 1989).Unfortunately, the toughness prevents spent hens use in whole meat food and reduces the market value (Sams, 1990., Lee *et al*., 2003). Hence, attempt should be made for obtaining better returns by the way of adopting suitable methods for economic utilization of spent hens. A better use of hens at the end of laying cycle, in the manufacturing of food products with higher added value, could provide economic profits.

Various innovated processes in food industry as power ultrasound (PUS), pulsed electric fields (PEF), high hydrostatic pressure (HHP), extrusion cooking (EC), magnetic fields (MF) and pulsed light (PL) have replaced or improved older and less efficient procedures. In modern food industry and food technology today extrusion processing becomes very important procedure and during past two decades is in expansion. This technology is advantageous, more effective, cleaner and less expensive with a product of the same quality or even better than manufactured with traditional technologies.

Extrusion is a process in which material is pushed through an orifice or a die of given shape. The pushing force is applied using twin-screw extruder. Extrusion processing of food materials has become an increasingly important manufacturing method, and its application has broadened substantially in the last two decades (Karwe MV. 1994).

The principle of operation is: raw materials are fed into the extruder barrel and screw(s) pushed toward die and cutter.

From transport phenomenon, extrusion process can be a combination of several processes such fluid flow, heat and mass transfer, mixing, shearing, particule size reduction, melting, texturizing, caramelizing, shaping and forming of different types of product (Karwe M.V. 1994). Depending on the product, one or many of these processes will take place in an extruder. Better process control strategies have to control the thermo-mechanical changes during extrusion to achieve desired product properties. Enrichment means that taste, colour, crispiness, other textural mechanical properties and complete amount of preserved proteins during processing should be balanced in best ratio.

Extruded puffed snacks are usually made from degermed corn or corn grits, wheat, rice or other cereals. There has been a remarkable growth in the varieties and popularity of such products because they are easily affordable, tasty, easy to make and nutritive. These products are flavoured with cheese, spices, onion, garlic or chilly and broadly fall in the fast food category. Blending of flours with meat in place of other vegetable products has not been tried yet in extrusion process. The present study was thus planned to standardize process for preparation of very popular and common snack food of all classes

2. Materials and Methods

The present study on development of hot extruded puffed product from spent hen meat was performed in various phases. The materials used and methodology employed during the study are discussed here under.

2.1 Source of raw materials

2.1.1 Spent hen meat: Approximately 72 weeks old spent hens (Kondaiah, N. 1993) reared at the Poultry Science Department of Bombay Veterinary College, Parel were procured, slaughtered and dressed according to traditional halal method. The body fat was removed and deboning (Alvarez,. *et al.* 1990) of dressed spent hen was done manually removing all tendons and separable connective tissues. Fresh spent hen meat thus obtained was used for further processing immediately.

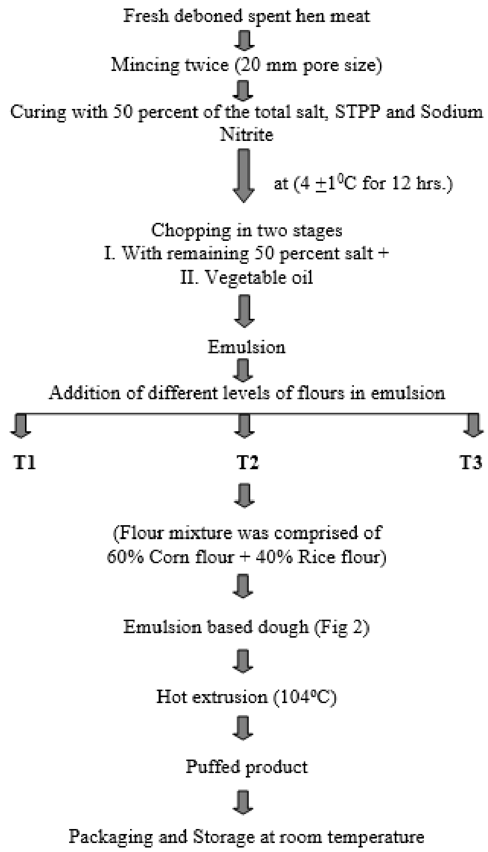
2.1.2 Ingredients mixture: The ingredients mixture formulation for spent hen meat emulsion used are Spent hen deboned meat (90.59%), Common salt (3%), Vegetable oil (6%), Sodium nitrite(0.01%),Sodium polyphosphate (0.4%). This was formulated on the basis of preliminary trials conducted in the Department of Livestock Products Technology, Bombay Veterinary College, Mumbai. Different proportions of ingredients were tried for one kg lot of spent hen meat emulsion in the preliminary trials.

2.2 Experimental details

2.2.1 To standardize spent hen meat emulsion based dough suitable for puffed product preparation.

The procedure for emulsion based dough from spent hen meat (Kondaiah, N. and B. Panda 1992) was standardized after several preliminary trials for one kg lot of spent hen meat emulsion based dough.

Modified method for preparation of spent hen puffed product



Where: **T_1** (15%emulsion 85% flour mixture)

T_2 (20%emulsion 80% flour mixture)

T_3 (25%emulsion 75%flour mixture)

2.2.2 Extrusion of Puffed product: A BTPL laboratory scale twin screw extruder (Alvarez *et al*., 1990) was used in Department of fish processing, Central Institute of Fisheries Education, Mumbai in the present study (Fig 1). The extrusion cooking was done on a twin screw extruder (BTPL LST EB10). The power of the motor kept at a speed (350 rpm) is 7.6 kW. A full-factorial design (two factors each at three levels and three replicates) was employed. Screw speed was kept constant (350 rpm) during the experiment. Moisture contents of the extrusion feeds were 14.3, 17.5, and 21.0%, respectively. The extruder temperature was set at 104^0C (Steel J.C., *et al.* 2006) where as barrel temperature was maintained 140^0c. Feed rate of volumetric feeder equipped with twin screw was set 14gm/min (Anisworth P *et al*., 1997).

A 2 mm circular die was used for extrusion (Riaz M. N. 2000). Materials to be extruded (emulsion and flour mixture) were mixed and formed dough and put into feeder hoop to reach the feed for extrusion. The moisture content of the feed analysed for which sampling done before putting to feeder hoop and kept the sample into hot air over for moisture analysis. Extruded product coming out the sieve (die) was collected in clean tray and sampling is done in two lots and packed in polythene bags among which one for sensory evaluation and another for chemical and microbial analysis.

Fig 1: Twin screw extruder (Department of fish processing, Central Institute of Fisheries Education, Mumbai)

2.3 Proximate Composition
The moisture, crude protein, fat and total ash contents of hot extruded puffed product were determined as per the standard procedures of Association of Official Analytical Chemists (AOAC, 1995).

2.3.1 Moisture: Around ten g accurately weighed sample was placed in hot air oven at 100±1°C for 16-18 hrs. After cooling it in desiccator for 10 min, the loss of moisture was determined and expressed as percent moisture of sample.
Moisture was calculated by using the following formula:

$$\%\text{Moisture} = \frac{M_{\text{INITIAL}} - M_{\text{DRIED}}}{M_{\text{INITIAL}}} \times 100$$

M_{INITIAL} = Initial weight of sample
M_{DRIED} = Final weight of sample

2.3.2 Fat: Accurately weighed samples of slices in thimbles were dried overnight at 50 ^{0}C in hot air oven. The fat was extracted with petroleum ether (BP 60-80 ^{0}C) in Soxhlet's apparatus. Extracts in oil flask was dried at 60^{0}C in hot air oven for overnight. Next day the oil flask was cooled and weighed. Ether extract was calculated by difference in weight of dried oil flask before and after extraction.

$$\text{Crude lipid content (\%)} = 100\,\frac{B-A}{C}$$

Where: A = weight of clean dry empty flask (g)
B = weight of flask with fat (g)
C = weight of sample (g)

2.3.3 Crude Protein: Nitrogen content of samples was estimated by the Kjeldahl method and protein content was expressed by multiplying the nitrogen value with constant factor 6.25 and taken as the crude protein content in the sample.
Calculation: Percent Nitrogen (N) %N (DM basis) =[(VHCl x NHCl) - (VBK x NNaOH) -(VNaOH x NNaOH)]/1.4007 X W X Lab DM/100
Where:
VNaOH = mL standard NaOH needed to titrate sample
VHCl = mL standard HCl pipetted into titrating flask for sample
NNaOH = Normality of NaOH
NHCl = Normality of HCl
VBK = mL standard NaOH needed to titrate 1 mL standard HCl minus B
B = mL standard NaOH needed to titrate reagent blank carried through method and distilled into 1 mL standard HCl
1.4007 = milliequivalent weight of nitrogen x 100
W = sample weight in grams

Calculation: Percent Crude Protein (CP)
CP (DM basis)= % N (DM basis) X F
F = 6.25

2.3.4 Ash Estimation: Place 2.5 to 5 g of dry sample in a crucible previously calcined and brought to constant weight. Place the crucible in a furnace and heat at 550°C for 12 hours; leave to cool and transfer to a dryer. Carefully weigh the crucible again with the ash.

$$\text{Calculation: } Ash\ content\ (\%) = \frac{100(A-B)}{C}$$

Where: A = weight of crucible with sample (g)
B = weight of crucible with ash (g)
C = weight of sample (g)

2.4 Sensory evaluation
The freshly prepared hot extruded puffed products were organolepticaly evaluated by panel of 5 judges. The panel was comprised of trained academic staff of the institute. The puffed product were judged for various sensory attributes using nine point descriptive scale (Keeton, 1983). The scores of 5 judges were averaged and recorded as mean value for sensory score. The judges were also requested to give their critical comments for the products (Appendix – I). Each panelist evaluated 3 samples (identified by codes) in a balanced sequential order. The entire fresh puffed product sample under treatment was served to panel of judges. They were also decoded differently at each time of judging for all four replications.

3. Results and Discussion
The present study on development of hot extruded puffed

product from spent hen meat was performed in various phases at the departments of Livestock Products Technology of Bombay Veterinary College and Fish Processing Department, Central Institute Fisheries Education, Varsova, Mumbai

In the initial stages of the experiment stable emulsion from spent hen was obtained after altering the process used for emulsion from broiler meat. The proper dough consistency was determined after several trials on various combinations of different types and levels of flours and spent hen meat emulsion to obtain a proper hot extruded puffed product. Various sieve sizes were also tried in the preliminary study and finally 2 mm diameter sieve size was used for extrusion. The moisture content of the feed, extrusion temperature and barrel temperature are very important for the manufacture of puffed products. Accordingly on the basis of preliminary trials the moisture content of the feed was maintained in the range of 14 to 22 percent for different treatments under study. The barrel temperature was maintained at 140^0C to obtain the extrusion temperature 104^0C. The steps / processes used in the preliminary trials were selected on the basis of suitable dough quality which was giving proper hot extruded puffed product. Thus the three treatments (T_1 – 15% emulsion + 85% flour mixture, T_2 – 20% emulsion + 80% flour mixture and T_3 - 25% emulsion + 75% flour mixture) as described in materials and methods were finalized and were replicated four times (Cai W., Diosady LL, Rubin LJ 1995).

Formulation and process standardization for hot extruded spent hen meat puffed product (SHPP)

After several preliminary trials for stable spent hen meat emulsion and various types and levels of flours, dough suitable for manufacture of puffed product was standardized (Carvalho, C. W. P., & Mitchell, J. R. 2000). The formulation of the dough for various treatments is depicted in Table 1 and the process adopted is already high lightened above in the Ingredients used topic.

Table 1: Composition of dough for hot extruded spent hen puffed product.

Treatments	Proportion of emulsion (%)	Proportion of flour mixture (%)	Types of flours
T_1	15	85	Corn flour (60%)
			Rice flour (40%)
T_2	20	80	Corn flour (60%)
			Rice flour (40%)
T_3	25	75	Corn flour (60%)
			Rice flour (40%)

Note: T_1 (Dough with 15% emulsion), T_2 (Dough with 20%emulsion), T3 (Dough with 25% emulsion)

The dough (Fig 2) obtained for three different treatments were extruded through laboratory scale twin screw extruder at extruder temperature 104^0C in 350 rpm speed and 2 mm diameter sieve size separately.

Spent hen puffed product (SHPP) thus obtained from each treatments were divided into two lots. The first lot was used for sensory evaluation and zero day analysis. Second lot was aseptically packaged in polyethylene bags and kept in airtight container to monitor the shelf life at regular interval.

Fig 2: A sample of dough prepared for the preparation of hot extruded puffed product (SHPP)

Fig 4: Hot extruded puffed product prepared with 20 % emulsion and 80% flour mixture (T2)

Fig 3: Hot extruded puffed product prepared with 15 % emulsion and 85% flour mixture (T1)

Fig 5: Hot extruded puffed product prepared with 25 % emulsion and 75% flour mixture (T3)

Proximate composition of spent hen puffed product (SHPP)

Table 2 depicts the value for various compositional characteristics of SHPP for all the three treatments. The moisture content of T_1, T_2 and T_3 was 4.59±0.20, 4.62±0.21 and 5.19±0.10 respectively. The moisture content of T_1 was significantly ($P \leq 0.01$) lower than T_2 and T_3 which could be ascribed to the lower proportion of spent hen meat emulsion in dough formulation. The moisture percent observed in the present study for all the treatments are well within the range of the earlier study on chicken snacks (Ing- jenq jean *et al*. 1996, and Singh *et al*., 2011).

From the Table 2 it is clear that the fat percent of T_1, T_2 and T_3 was 1.47±0.13, 1.98±0.01 and 2.87±0.05 respectively.

The significance difference in the fat content among T1, T2 & T3 could be ascribed to spent hem meat used for dough formulation. The fat percent observed in the present study for SHPP is lower than the one reported by Singh *et al*. (2011) for chicken snacks. This could be ascribed to the type of meat and other ingredients used for dough formulation. In the present study no oil was used for the dough formation.

The protein content observed for T_1, T_2 and T_3 was 10.63±0.23, 12.99±0.18 and 13.92±0.03, respectively. The protein content of T3 significantly ($P<0.05$) differed from that of T1 and T2. The higher percent of protein in T_3 than T_2 and T_1 could be ascribed to higher proportion of spent hen meat emulsion in dough formulation. The protein percent found in the present investigation for all the treatments is within the range with the earlier study on extruded product and for chicken snacks (Singh *et al*., 2011).

From Table 2 it is clear that the average ash values of SHPP was 0.89±0.02, 0.99±0.01 and 1.04±0.03 of T1, T2 and T3 respectively. The ash content of T1 significantly ($P<0.05$) varied from that of T2 and T3. This could be ascribed the higher proportion of flour mixture in T1 than T2 and T3.

Table 2: Proximate composition of spent hens meat puffed product (SHPP)

Parameters	T_1	T_2	T_3	Average
Moisture (%)	4.59±0.20	4.62±0.21	5.19±0.10	4.80±0.13
Fat (%)	1.47±0.13^{c}	1.98±0.01^{b}	2.87±0.05^{a}	2.11±0.21
Protein (%)	10.63±0.23^{b}	12.99±0.18^{b}	13.92±0.03^{a}	12.51±0.50
Ash %	0.89±0.02^{b}	0.99±0.01^{a}	1.04±0.03^{a}	0.97±0.02

Note: T_1 (Dough with 15% emulsion), T_2(Dough with 20%emulsion),T3 (Dough with 25% emulsion)

Anova: **4.2(A):** Proximate composition and sensory attributes of hot extruded puffed product

Parameters	Treatment			Error		F- value	Sig.
	Df	Sum of Squares	MS	Df	MS		
Moisture	2	0.68	0.339	6	0.095	3.582	0.095
Fat	2	3.03	1.512	6	0.021	72.988**	0
Protein	2	17.32	8.657	6	0.086	101.178**	0
Ash	**2**	0.03	0.016	6	0.002	9.842*	0.013

*Significance at the level of ($P<0.05$),
** Significance at the level of ($P<0.01$).

4. Summary and Conclusions

The present investigation was planned for the development of hot extruded puffed product from spent hen meat. Before standardizing the final process, preliminary trials were conducted on various aspects like different method of processes, ingredients etc. (The proper emulsion was obtained after altering the process used for emulsion from broiler meat). The proper dough consistency was determined after several trials on various combinations of different types and levels of flours and spent hen meat emulsion. The steps used in the preliminary trials were selected on the basis of suitable dough quality which was giving proper extruded puffed product. The three treatments (T_1 -15% emulsion + 85% flour mixture, T_2- 20% emulsion + 80% flour mixture and T_3- 25% emulsion + 75% flour mixture) were finalized and were replicated four times.

From the above discussion and the summary it can be concluded that:

1. Puffed product from flour mixture admixed with spent hen meat emulsion in different proportion can be effectively manufactured by using twin screw hot extruder.
2. Value addition of spent hen meat is possible by utilizing it into expandable hot extruded puffed product.
3. Further studies are required on packaging technique to enhance the shelf life of spent hen puffed product.

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