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Changes in quality of egg gravy during storage

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Eggs are good source of protein and a real substitute for pulse protein for most of the non-vegetarians. Significant rise in the number of single working men and women professionals in the recent past has opened a wide market for the ready to eat foods. Eggs of 5 to 20 days old, heated in boiling water for 10 minutes peeled easily with minimum edible loss. Gravy prepared using onion, tomato and other spices was cooled and packaged in retort, PP and LDPE pouches along with eggs at 3:2 (v/v basis) after mixing with 0.8 per cent citric acid. The pouches were thermally processed at 95±2°C for 30 minutes in hot water bath and cooled. Eggs packaged along with gravy in retort pouch recorded the lowest pH value of 4.70, the highest TSS value of 12.7°Brix, minimum hardness and springiness values of 12.06N and 0.808 at 15°C after 45 days of storage, respectively. Retort pouch containing eggs in gravy and stored at 15°C and gravy in LDPE pouches and stored at 15°C recorded minimum total colour change value of 7.03 and 11.8 for gravy and egg yolk after 45 days storage, respectively. Bacterial and yeast loads were well within (10^4 cfu /g) spoilage range in all refrigerated pouches. Under ambient condition, products were found to be fit for consumption till 32, 16 and 24 days of storage in retort, PP and LDPE packaging material, respectively. Products packaged in retort pouches scored maximum score values of 8.0 and above to Hedonic scale during sensory evaluation The production cost of one pouch eggs in gravy packaged in retort, LDPE and PP was estimated as Rs.13.80, Rs. 10.60 and Rs.10.55, respectively.

Key Words : Boiled eggs, Flexible packaging, Ready to eat products, Retort pouch

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INTRODUCTION

Quality attributes of food products are influenced by several factors, such as ingredients, thermal effects, emulsification, acidification and interactive effects. Traditional Indian egg-based foods require many unit operations and longer preparation time. In order to minimize such drudgeries of processing the kitchen and to cater to the needs of the increasing population of working couples and single persons living alone, the demand for ready - to eat products is growing in Indian and overseas markets.

The most common egg gravy preparations in Indian households are varying forms of curries with a profuse use of spice. Variations from products to product are affected by difference in the kinds of egg and spices, their relative proportions and the consistency of the gravy. Sukhwinder Kaur *et al*. (2000) made an attempt to standardise the formulation and studied the sensory, physico-chemical and microbiological properties of egg halwa. A few products in the curried form are available canned. Metal cans impart an undesirable taste to the product during storage (Srinivasa *et al.,* 1999). The tin plate for making cans is imported to India and is expensive (Srinivasa *et al.,* 1999). Moreover, aluminum containers are of poor mechanical strength and prone to

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a high incidence of leakage through the seams (Srinivasa Gopal *et al.*, 1999).

The process for production of fish curry in flexible pouch (polyester/Al foil/cast polypropylene) was standardized by Srinivasa *et al.* (1999). They observed no changes in product quality during storage for over a year at 30 ± 2^{0}C. Changes in quality during chilled/frozen storage have been studied in chicken nuggets (Lai *et al.*, 1995 and Modi *et al.*, 2004). A new method of preparation of egg gravy and changes in its quality during storage [Ambient and Refrigerated (12^0 and 15^0 C)] storage for one and half months after flexible-pouch packing were examined for the present study.

METHODOLOGY

Fresh poultry eggs layed by healthy layers were received from M/s Anbu Poultry farm Muthukkalipati village, Rasipuram (Tk), Namakal (Dt), Tamil Nadu. Medium sized eggs with 55±5g 'A' grade quality were chosen for the present study.

Preparation of gravy:

The gravy prepared contained the ingredients as mentioned in the Table A. The onion, ginger and garlic were peeled and washed thoroughly with clean potable water and chaffed whereas tomatoes were washed before cutting. The other ingredients were made ready as per the recommended quantity. A clean pan with a predetermined quantity of refined oil was kept over medium flame and the chaffed onions were introduced and fried. Then it was followed by garlic, ginger and tomato. The pool was fried uniformly under medium flame with frequent mixing till the mass turns amber brown colour. Remaining ingredients were introduced one after the other and stirred continuously. Then, the pan was removed from the flame and allowed to cool and fried mass was ground into fine paste using a maxi. Small quantity of water (50 to 75 ml) was used to scant the paste from the mixie jar and some other utensils. Ground paste was again introduced into a pan containing hot oil and it was kept over medium flame till the oil from the inner periphery of pan starts oozing out. Finally, addition of salt completed the process of gravy preparation. Preservative (citric acid 0.8%) was added to the gravy after cooling and it was mixed thoroughly. Fresh eggs of minimum 5 days and less than 20 days old were used for this study, boiled and peeled eggs were introduced into the pan and allowed to get heated for 5 minutes on light flame. The entire gravy product was packed in different pouches with 100 g of eggs and 250 g of gravy in each pack. Each sealed packet was placed ambient condition and refrigerated conditions (12^0 and 15^0 C). The preparation of the product, packing, storage and sampling for quality evaluation was repeated six times.

Table A : Quantity of ingredients used to prepare gravy

Sr. No.	Ingredients	Quantity(g)
1.	Small onion (peeled and thoroughly washed)	1000
2.	Tomato	150
3.	Refined oil	200
4.	Ginger (peeled and thoroughly washed)	50
5.	Garlic (peeled and cut)	75
6.	Turmeric powder	10
7.	Red chilly powder	6
8.	Spice mix 'A' [coriander, cumin, black pepper (4:3:1.5)]	35
9.	Spice mix 'B' [cinnamon, cloves, cardamom (4:3:1)]	8

Quality evaluation:

The packets were removed at 0 (freshly prepared), 8, 15, 30, 45 and 60th day of storage from ambient storage and refrigerated (12^0 and 15^0 C) and submitted to the following analyses.

Physical, bio-chemical and textural parameters :

Moisture content in egg albumin:

Moisture content in egg albumin portion of egg is a parameter varies during storage days. Oven drying of the known quantity of albumin portion (3 to 5g) at 102°C was adopted to estimate moisture evaporated. Weight of the sample was taken with frequency of 1 hour till constant weight was obtained. The sample reached constant weight within 5 to 6 hours and the moisture constant was estimated using following formula :

$$\text{Moisture content \% (dry basis)} = \frac{W_m}{W_d}$$

where,

W_m = weight of moisture, g

W_d = weight of dry matter, g

Colour:

Colourflex (Hunter Associates Laboratory, Inc.,

Reston, Virgina, USA) meter was used for the measurement of colour. The data were sensed from the sensor (colourflex 45°/0°) and supported by Universal software V4.10 software package. The change in colour of the egg albumin, yolk and gravy was expressed as the total colour difference (ΔE). The (ΔE) was determined using L, a, b colour co-ordinates

pH:

Glass rod pH meter (Micro processor based pH meter, 1012E, Environmental and Scientific Instr. Co., India) was used in the experiment, where initially it was calibrated using two freshly prepared buffer solutions (pH 4 and 7). Then the readings were taken by dipping the electrode into the sample.

Texture analysis:

The texture of the product is of great importance in determining the quality and acceptability of the boiled egg. Texture analysis measures force, distance and time thus providing three-dimensional product analysis. The hardness and springiness of boiled egg before and after heat treatment were determined using texture analyzer (MacNeil, 1997). The Textural Profile Analysis (TPA) was analyzed by using the Texture Analyzer. The Texture Analyzer is a microprocessor controlled texture analysis system, which is interfaced to a personal computer.

Microbial load:

The analysis was done for packaged boiled eggs with gravy. One gram of boiled egg with gravy (well ground with proper proportion of albumin and yolk) was added to 9 ml of sterile distilled water taken in a conical flask to make 10^{-1} dilution. The conical flask was shaken thoroughly for 30 seconds. Then 1 ml of the diluted solution was accurately pipetted into a test tube containing 9 ml of sterile distilled water to obtain 10^{-2} dilution. The dilutions are repeated for obtaining 10^{-4} dilutions. One ml of sample was taken from each dilution and the microbial growth test was replicated twice per dilution in sterilized Petri dish. The bacterial count was taken after 2 days whereas fungal was taken after four days (Adesiyun *et al.*, 2005). The number of organisms per gram of sample was calculated using the formula furnished below :

$$\text{Number of colony forming units (cfu) per gram of the sampel} = \frac{\text{Mean number of cfu x Dilution factor}}{\text{Quantity of sample on weight basis}}$$

Sensory quality:

The egg gravy product in a packet was warmed in a hot pan (80–90^{0}C) for 3–4 min. The coded samples were subjected to sensory quality evaluation by 10 in-house trained panellists using a 9-point hedonic scale (ASTM, 1996; Modi *et al.*, 2003). The mean score for each attribute (colour, flavour, mouth feel, consistency of gravy, texture and overall quality) was reported.

Cost analysis:

The cost of production of egg with gravy was worked out by considering the building cost (rental basis), machinery cost, raw material cost and labour cost after making reasonable assumptions wherever necessary (Kailappan, 1981).

Statistical analysis:

The experiment had a Completely Randomized Design with six replicates. Preparation of egg gravy in six batches on different days represented the replicates. Sampling month was included as a factor in the model. The mean values for all parameters were examined for significance as a function of storage period by analysis of variance. When significance (*P*_0.05) was observed, means separation was accomplished.

OBSERVATIONS AND ASSESSMENT

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Preliminary studies :

Some preliminary studies were conducted to reduce the number of experiments in the present study and to get nutritionally good and organoleptically acceptable quality egg to the ultimate consumers. In the present study, time temperature combination for the preparation of boiled eggs, levels of different constituents to be added for the preparation of gravy, pouch size and filling ratio of egg to gravy in the pouch were completed under the preliminary studies.

Physical, biochemical, microbiological and textural characteristics of freshly boiled eggs and gravy :

Physical, biochemical, microbiological and textural characteristics of freshly boiled egg and freshly prepared gravy used in the present study are presented. For increased shelf-life, the pH of the product should be

minimum (Modi, 2004). From the study it is seen that the boiled eggs packaged along with gravy in retort pouch recorded a lowest pH value of 4.70 even after 45 days of storage at 15°C. Under ambient condition retort pouch recorded a pH of 4.85 after 30 days of storage. All other treatments recorded higher pH values.

In the case of total colour change value of gravy, retort pouch containing eggs and gravy stored at 15°C recorded minimum ΔE value of 7.03 after 45 days of storage. Gravy packaged in other pouches and stored at refrigerated condition recorded higher values. Under ambient condition, the gravy packaged in retort pouches recorded 30 days of shelf-life with ΔE value of 5.40. The eggs packaged along with gravy in LDPE pouches and stored at 15°C recorded minimum total colour change value of egg yolk of 11.18 after 45 days of storage (Fig.1A). Under ambient condition, retort pouch alone recorded a shelf-life of 30 days with a ΔE value of 19.72. Increase in total colour change value of egg albumin makes the egg to become light yellow in colour (colour of gravy) which was highly accepted by the consumers. The boiled eggs packaged along with gravy in polypropylene pouch stored at 12°C recorded a maximum value of 35.07 after 45 days of storage. Under ambient condition retort pouch alone recorded a shelf-life of 30 days with ΔE value of 37.50.

In the case of moisture content of egg albumin, eggs packaged along with gravy should record higher values in moisture content of albumin so as to keep the albumin portion in soft condition. Among the different treatments studied, boiled eggs packaged along with gravy in retort pouch and stored at 15°C recorded maximum albumin moisture content value of 85 per cent after 45 days of storage (Fig. 1B). Under ambient condition also retort pouch recorded 30 days of shelf-life with egg albumin moisture content of 84.97 per cent.

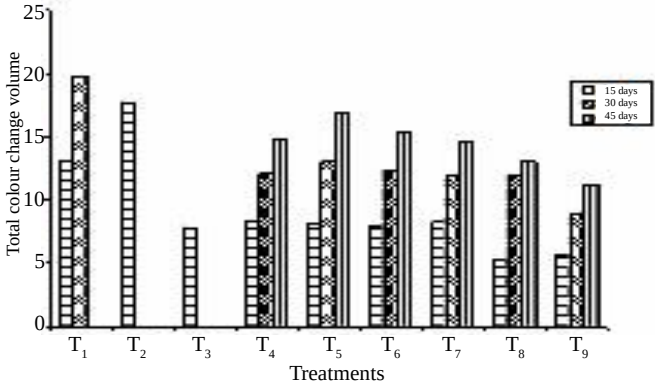

Fig. A : Total colour change values (aE) of egg yolk packaged along gravy in flexible pouches.

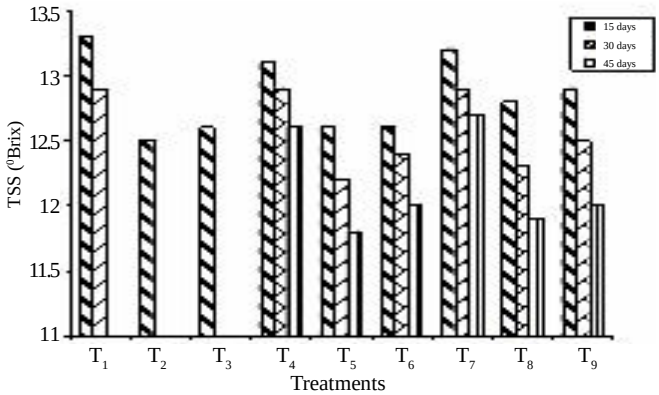

Fig. C : Total soluble solids (TSS) of gravy packaged along with boiled eggs in flexible pouches

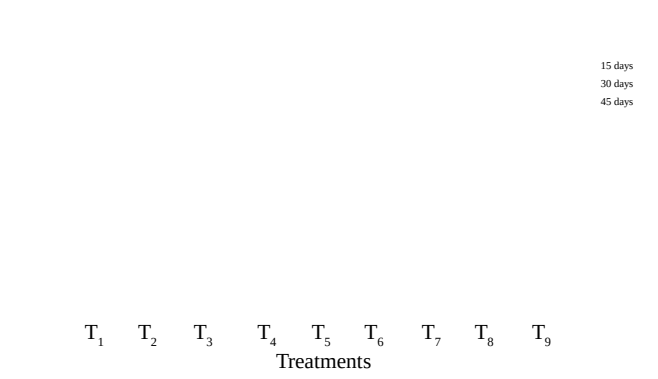

Fig. B : Moisture content of egg albumin packaged along gravy in flexible pouches.

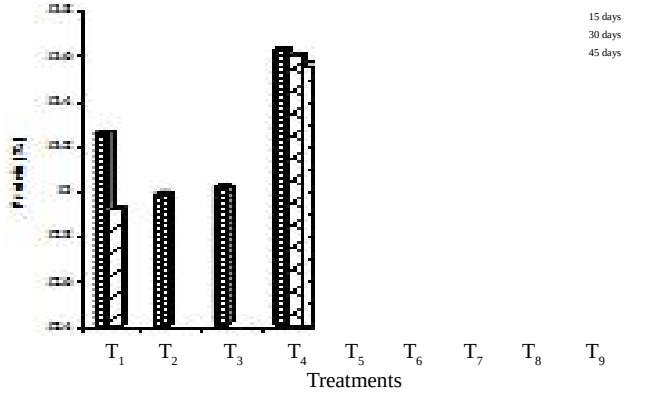

Fig. D : Total protein content of boiled egg packaged alongwith gravy

Fig. 1 : Effects of packaging materials, storage conditions and duration of storage on quality parameters of egg gravy during storage

Higher the TSS values of gravy more the solid fraction, which is preferred by the consumer. Gravy packaged along with eggs in retort pouches stored at 15°C recorded a maximum value of 12.7°Brix after 45 days of storage (Fig. 1C). All other treatments studied recorded lesser values only. Under ambient condition, except retort pouch product in other two types of pouches studied recorded only 16 and 24 days of shelf-life. The gravy packaged along with eggs in retort pouch and stored under ambient condition recorded 30 days of shelf-life with a TSS value of 12.9°Brix.

Eggs are known for its nutritive value mainly protein as its important constituent. Among the different types of packaging materials and storage conditions studied, boiled eggs packaged along with gravy in retort pouch and stored at 12°C recorded a maximum protein content of 13.55 per cent after 45 days of storage (Fig. 1D). Under ambient condition the same pouch recorded a shelf-life of 30 days with 12.91 per cent protein content.

For all food products, irrespective of their quality textural property of the products are very much essential for their acceptance by the consumer. Among different textural properties, hardness and springiness values are considered as important parameters used to measure the acceptability. The hardness and springiness value of boiled eggs should be minimum for their palatability. In the present study Table 1 indicates among the different treatments studied, eggs packaged in gravy in LDPE pouch recorded a minimum hardness value of 11.73 N at 12°C storage temperature and retort pouch recorded 12.06 N under 15°C storage condition after 45 days of storage. Also, the eggs in retort pouch stored at 15°C storage condition recorded minimum springiness value of 0.808 after 45 days of storage. Under atmospheric condition eggs packaged in retort pouches showed 30 days of shelf-life and recorded a hardness and springiness values of 10.25N and 0.725, respectively after 30 days of storage.

To get increased shelf-life, the eggs in gravy should record minimum microbial load and should be less than 10^4 cfu/g. In the present study, eggs packaged along with gravy in retort pouch and stored at 12°C and 15°C

Table 1 : Changes in hardness value of boiled eggs packaged along with gravy in different pouches and stored at different temperatures

Treatments	Textural properties (N)							
	Before heat treatment		After 15 days		After 30 days		After 45 days	
	Hardness	Springiness	Hardness	Springiness	Hardness	Springiness	Hardness	Springiness
T_1	10.63	0.693	10.32	0.754	10.25	0.725	10.01	
T_2	10.63	0.693	10.05	0.597				
T_3	10.63	0.693	10.25	0.663				
T_4	10.63	0.693	11.98	0.816	12.02	0.831	12.58	0.845
T_5	10.63	0.693	11.52	0.811	11.97	0.829	12.63	0.867
T_6	10.63	0.693	11.43	0.808	11.75	0.809	12.15	0.823
T_7	10.63	0.693	11.36	0.801	11.67	0.807	12.06	0.808
T_8	10.63	0.693	11.49	0.809	11.85	0.813	12.24	0.817
T_9	10.63	0.693	11.23	0.746	11.56	0.756	11.73	0.810

Table 2 : Microbial load (Yeast and Bacteria) of poultry egg with gravy packed in different pouches at different conditions

Treatments	Storage period (days)									
	Yeast (cfu)					Bacteria (cfu)				
	8	16	24	32	45	8	16	24	32	45
T_1	3.5	5.0	8.3	9.3	$2.5x10^3$	11.33x10	$2.33x10^2$	$4.5x10^3$	$9.5x10^3$	$4.5x10^5$
T_2	4.7	9.1	$5.0x10^2$	$9.2x10^3$	$4.1x10^4$	$3.55x10^3$	$9.4x10^3$	$7.63x10^6$	$4.63x10^7$	$6.25x10^7$
T_3	3.9	8.1	9.1	$9.0x10^2$	$3.9x10^3$	$8.56x10^2$	$1.77x10^3$	$9.55x10^3$	$4.20x10^7$	$5.62x10^7$
T_4	1.3	1.9	2.3	4.5	5.6	$3.67x10^1$	$4.98x10^1$	11.33x10	$2.33x10^2$	$2.89x10^2$
T_5	2.2	2.9	3.3	4.5	6.5	$8.3x10^1$	$3.65x10^2$	$8.56x10^2$	$1.77x10^3$	$3.55x10^3$
T_6	1.3	2.0	3.2	3.9	6.3	$6.8x10^1$	$3.14x10^2$	$6.67x10^2$	$9.1x10^2$	$2.56x10^3$
T_7	1.6	2.2	3.7	6.1	6.3	$3.9x10^1$	$5.2x10^1$	$3.2x10^2$	$3.9x10^2$	$5.3x10^2$
T_8	2.3	3.2	3.6	5.1	8.0	$2.33x10^1$	$3.92x10^2$	$6.7x10^2$	$1.12x10^3$	$2.74x10^3$
T_9	1.8	2.5	5.2	8.6	9.0	$3.25x10^2$	$7.1x10^2$	$9.81x10^2$	$1.15x10^3$	$3.1x10^3$

recorded a minimum bacterial load of 2.89 x 10^2 cfu/gram and 5.3 x 10^2 after 45 days of storage as seen in Table 2, respectively. In the case of yeast, the same treatments recorded minimum values of 5.6 and 6.3 cfu/g at 12 and 15°C storage conditions. Under ambient storage condition, eggs and gravy packaged in retort pouches recorded a shelf-life of 30 days with bacterial load of 9.5 x 10^3 cfu/gram and yeast load of 9.3 cfu/gram which is within acceptability. All other flexible pouches containing eggs in gravy stored under ambient condition reported as fit for consumption recorded the microbial load below acceptable limit.

Sensory evaluation of any food material is a qualitative assessment about that food, which indicates the acceptability of food material by its ultimate consumer. While preparing a new food product it is important to borne in mind that the organoleptic acceptability of food is equally important like its nutritive value. Organoleptic evaluation was carried out on the eggs packaged along with gravy in different pouches and stored at different conditions. Among the different treatments studied, retort pouches recorded a score value of 8.0 and above in all the storage conditions and durations studied.

From the above discussions, it is clear that the boiled eggs along with gravy packaged in retort pouches and stored at 15°C recorded many of the quality attributes like pH, TSS, protein etc., with in the acceptable limit Hence, this treatment is adjudged as the optimum process for packaging of eggs along with gravy.

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