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Development of 'ready-to-eat' product using poultry eggs

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In the present study, a process for the production of 'ready-to-eat' eggs in gravy has been optimized. Eggs used for the present study were boiled for several temperatures and time combinations by considering the age of the eggs, ease of peeling and edible loss during peeling. The five days old egg boiled for 8 minutes recorded minimum hardness value of 6.62 N with 2.5 per cent edible loss and 20 days old eggs boiled for 11 min recorded maximum hardness of 10.23 N with 0.19 per cent edible loss. Similarly, the weight of edible portion and shells of boiled eggs ranged from 86.78 to 90.70 per cent and 8.91 to 11.69 per cent, respectively. The study clearly revealed that eggs to gravy in 2:3 ratio filled in 20 x 15 cm pouches was suitable and hence adjudged as optimum pouch size and filling ratio. Boiled eggs packed in pouches along with gravy and thermally processed at 95±2^{0}C for 30 minutes recorded a hardness value less than 13.0 and under organoleptical evaluation recorded maximum value (8.76). The freshly boiled eggs used for the present study were white in colour, as for as albumin is considered and recorded an 'L' value of 84.54 and yolk was light yellow in its appearance and recorded a 'b' value of 47.85. Gravy prepared for the study was brownish red in appearance and recorded a 'b' value of 53.03 and 'a' value of 11.52. Gravy recorded a TSS value of 14.8^0 Brix and a pH value of 6.8 indicating that it is neutral in nature. The texture of egg was highly soft with completely solidified condition of both albumin and yolk. The albumin moisture content was about 83.07 per cent and recorded a hardness value of 9.63N and a springiness value of 0.556. The protein content of boiled egg was 13.65 per cent.

Key Words : 'Ready-to-eat', Boiled poultry eggs, Gravy

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INTRODUCTION

Egg is one of the most nutritious foods available in nature and contributes valuable nutrients to its consumer from its high-quality protein, significant levels of beneficial vitamins, antioxidants and other important constituents. Egg has the highest quality protein in the food supply with the amino acid pattern almost matching the human requirement for essential amino acids. Eggs and milk contain more amino acids for growth and tissue maintenance of human beings than even meat, including beef, chicken, pork and fish. Knowing the nutritional status of the poultry egg, US Food Guidance System included egg in the meat, fish, poultry, nuts and beans group (*www.whfoods.org*).

Egg is used as a side dish along with regular diet as per Indian food habit. Hard and soft boiled, half boiled, omelet, egg pulav, egg with onion, egg roast, egg parota, egg fried rice etc., are different forms under which the Indian consumers eat egg daily. Because of low price, egg is also called as poor man's non vegetarian diet. It is a real substitute for the pulses as for as proteins are concerned and gives a mouth feel of eating chicken. Because of its high nutritive value and wholesome food, Government of Tamil Nadu followed by GOI introduced egg in "mid day meal" programme for school children and same is being followed by Government of India later.

Outer cover, the so called egg's shell acts as a natural packaging material and protects different constituents present in the egg from spoilage. This protective cover of the egg allows the marketing people to carry it to different places and distribute the same to different people with out much risk. Because of its fragile nature, much care has to be taken while transporting, handling, storage and distribution of egg. High nutritive value of egg leads to microbial spoilage even a small fissure occurs on its surface. Plastic or paper board crates specially designed

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and moulded are the common means for packaging eggs and prepare them for long distance transportation. However, losses are occurred because of bad road conditions in rural and suburban areas. Once the egg is processed in one or the other form, the danger of breakage and spoilage can totally be eliminated.

Processing of egg in time with above principle will not only avoid post harvest loses but also reduce the short fall in the egg availability in the global scenario. There are many food products made from different food materials are already available in the market in various forms. Processing and packaging of egg with gravy in flexible pouches as designed in present study will become one of such product made available to the consumers in ready-to-eat (RTE) form in wholesome manner. This will increase the egg consumption by different age groups and meet the needs of many egg consumers. Hence, a research study on processing of poultry egg with gravy has been taken up.

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. The poultry firm supplied one day old eggs and they were kept at observation in ambient condition for 5 days so as to make the egg suitable for soft boiling and easy peeling of shell. Eggs of uniform size and shape from the same batch without any fissures on the surface of shell were used for present study.

Different raw materials of food grade quality were identified and purchased for the preparation of gravy. Preliminary studies were conducted with different combinations of raw materials so as to identify a recipe which could be palatable well with the eggs and also suitable to eat along with cooked rice or idly or dosa. The detailed composition of recipe is given in Table A.

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 where as 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 mixer 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. Boiled and peeled eggs were introduced into the pan and allowed to get heated for 5 minutes on light flame.

The boiling temperature and duration was optimized for the study with various preliminary tests. Fresh eggs of minimum 5 days and less than 20 days old were used for this study, since it recorded acceptable quality. Eggs were immersed into the boiling water and allowed for 10 minutes to get the solidified egg yolk and albumin. Soon after 10 minutes treatment, eggs were placed in cold water to stop further heat penetration. Careful hand peeling was followed to get wholesome eggs without loss of edible portion through shell. Peeled eggs were immediately transferred into pan containing prepared gravy and heated for 5 minutes then transferred to the pouches for packaging, thermal processing and storage.

Preservative was added to the gravy after cooling to the atmospheric temperature. Based on the preliminary studies, the pouches were filled with optimized proportion of the eggs

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'	35
9.	Spice mix 'B'	8

to gravy (2 parts of egg in 3 parts of gravy by volume). To avoid more head space with air, the pouches were sealed as close as to the gravy in the pouches.

Since egg protein is very sensitive to high temperature and the albumin portion took rubbery texture when exposed to temperature more than 100^0C, to retain the texture and quality of eggs filled in pouches were thermally processed at temperature below 100^0C after making it as medium acid food. The advantage of the thermal processing using preservatives is that the micro-organisms could be suppressed to a great extent and its proliferation can be controlled. Citric acid (0.8%) was used as preservative serve at the end of sterilization process. Retort pouch is a good thermal transistor through its effective surface area as well as materials of constitution. Heat treatment process helped to kill some micro-organisms that took their entry during process and during handling. Hot water is a good heat transfer media that helped to transfer heat more efficiently when the need is below 100^0C. Temperature of water used in the water bath was kept well above than the temperature that is needed to be achieved in the product. Pouches were placed firmly on the tray available in the water bath container to accommodate the pouches and tray was very well immersed inside the water. Heat treated samples were immediately transferred to cold water to arrest further heat penetration. Different unit operations performed to make ready-to-eat poultry egg with gravy in retortable pouches is given in Fig. 1.

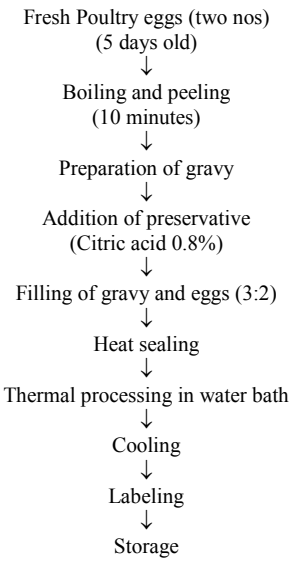

Fig. 1. Process flow chart for the preparation of RTE products using boiled poultry eggs in gravy

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

Oven drying of the known quantity of boiled egg (3 to 5g) at 102^0C was adopted to estimate moisture evaporated. The sample reached constant weight within 5 to 6 hours and the moisture constant was estimated using following formula:

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

where,

W_m = weight of moisture, g

W_d = weight of dry matter, g

Colourflex (Hunter Associates Laboratory, Inc., Reston, Virgina, USA) meter was used for the measurement of colour. Glass rod pH meter (Micro processor based pH meter, 1012E, Environmental and Scientific Instr. Co., India) was used in the experiment. The hardness and springiness of boiled egg before and after heat treatment were determined using texture analyzer.

Protein content was estimated by Kjeldahl method using a laboratory Kjel plus equipment (Pelicon equipments, model-REC 22238-A2, Chennai). The protein content was obtained by multiplying the per cent of nitrogen with the factor 6.25.

The aerobic micro flora *viz.,* bacteria and yeast present in the sample were assessed by dilution plate technique with nutrient agar and potato dextrose agar medium obtained from authenticated laboratories. The number of organisms per gram of sample was calculated using the formula furnished below:

$$\left.\begin{matrix}\text{Number of cfu} \\ \text{per gram of the sample}\end{matrix}\right\} = \frac{\text{Mean number of cfu x Dilution factor}}{\text{Quantity of sample on weight basis}}$$

where,

cfu= Colony forming units

An organoleptic evaluation of the product was done for colour, flavour, texture, taste and overall acceptability (Ranganna, 1997). All the samples were displayed to the judges under ambient conditions. Nine-point Hedonic scale was used as sensory evaluation score card to bring out the inherent characteristics acceptability of particular product.

OBSERVATIONS AND ASSESSMENT

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 optimized.

Different constituents for the preparation of gravy:

The quantity of the different constituents to be mixed for the preparation of gravy was analyzed, so that the consumer can get the mouth feel of eating eggs and the gravy go well with cooked rice, idly or dosa normally consumed along with egg and gravy.

Table 1 gives the different constituents and their levels used for the preparation of gravy. Among the three different

Table 1. Levels of different constituents used for the preparation of gravy to pack along with boiled eggs in flexible pouches

Sr. No.	Ingredients	Quantity(g)		
		A	B	C
1.	Small onion (peeled)	1000	950	900
2.	Tomato	150	130	120
3.	Refined oil	200	200	180
4.	Ginger (peeled)	50	40	45
5.	Garlic (peeled and cut)	75	65	65
6.	Turmeric powder	10	8	8
7.	Red chilly powder	6	7	8
8.	Spice mix 'A'	35	30	27
9.	Spice mix 'B'	8	7	9

constituent levels evaluated organoleptically, composition 'A' was accepted with higher values of overall acceptability using Hedonic scale.

Age, temperature and duration of boiling for preparation of boiled eggs suitable for packaging along with gravy:

Eggs of 5 to 20 days old were used in this experiment, as these eggs are of assured quality and safety. Fresh eggs were introduced in the boiling water for different durations and the ease of peeling and edible loss was observed. The tests were conducted on different age eggs such as 5, 10, 15 and 20 days old. The edible loss and hardness of eggs when different aged eggs exposed to different duration of boiling are shown in Table 2.

From the Table 2, in general it is seen that irrespective of the age of eggs, increase in duration of boiling time reduced the edible loss through the peeled shells and increased the hardness value. Among the different experiments conducted, 10 days old eggs recorded minimum edible loss and 5 days old eggs recorded higher edible loss. Also five days old egg boiled for 8 minutes recorded minimum hardness value of 6.62 N with 2.5 per cent edible loss and 20 days old eggs boiled for 11 min recorded maximum hardness of 10.23 N with 0.19 per cent edible loss. From the experiments conducted it is observed that the weight of edible portion of boiled eggs ranged from 86.78 to 90.70 per cent of whole egg. The shells of the boiled eggs after peeling ranged from 8.91 to 11.69 per cent. Among the different experiments studied, ten days old egg boiled at 100^0C for 10 minutes recorded 0 per cent edible loss with minimum hardness value.

Pouch size, egg to gravy ratio for packaging eggs along with gravy:

The main aim of this process is that after packaging, the

Table 2. Boiling and peeling tests conducted on poultry eggs

Sr. No.	Age of the egg after laying (days)	Duration of boiling (min)	Boiled whole egg weight (g)	Edible wt (%)	Peel wt. (%)	Edible loss (%)	Hardness (N)
1.	5	8	57.6	87.67	10.06	4.34	6.62
		9	56.0	86.78	11.25	3.94	7.12
		10	53.9	90.35	9.27	0.74	7.98
		11	56.2	90.21	9.43	0.69	8.54
2.	10	8	59.0	87.28	11.69	1.01	8.42
		9	55.0	88.54	10.72	0.72	9.12
		10	53.2	89.47	10.52	0.00	9.63
		11	57.3	89.87	10.12	0.00	10.07
3.	15	8	52.7	90.70	8.91	0.77	9.32
		9	53.6	90.29	9.32	0.37	9.56
		10	58.6	88.73	11.09	0.32	9.75
		11	56.3	90.23	10.12	0.33	10.06
4.	20	8	53.6	87.50	10.63	3.88	9.01
		9	54.9	87.43	11.11	2.96	9.33
		10	58.0	88.10	11.72	0.32	9.69
		11	56.2	90.03	9.78	0.33	10.23

eggs should be totally immersed in the gravy and number of eggs and quantity of gravy used should be sufficient for consumption along with cooked rice or other types of breakfast items (Singh and Panda, 1989). Normally after packaging, the flexible pouches will be kept in the natural rest position *i.e.* flat on shelves. Irrespective of pouch orientation, in all positions both eggs kept in gravy should be totally immersed in the gravy.

With these aims, pouches of 10 x 15, 15 x 20 and 20 x 25 cm sizes were filled with 1:1, 1:2, 1:3, 2:2, 2:3 and 2:4 of egg to gravy ratio by volume and sealed. While sealing, minimum but sufficient head space were provided for the eggs to move and to avoid cross contamination. The study clearly revealed that eggs to gravy in 2:3 ratio filled in 20 x 15 cm pouches was suitable and hence adjudged as optimum pouch size and filling ratio.

Temperature and duration for thermal processing of eggs in gravy packed in flexible pouches:

The earlier heat treatment experiments conducted with flexible pouches containing eggs in gravy for sterilization using steam resulted in the formation of rubbery texture to the albumin portion of the soft boiled eggs used in the study. To overcome this problem, the temperature of the heat treatment which was lowered and tried for different temperature and time combination which is well above 85^0C, the controlling temperature of *Clostridium botulenium* an anaerobic microorganism causing spoilage in hermetically sealed packages.

In the present study, temperature of 90±2, 95±2 and 97^0C were selected since, these temperatures were well above 85^0C and below the boiling point of water. Duration for heating was fixed as 25, 30 and 35 minutes. The results obtained during different tests are recorded in Table 3.

From the Table 3, it is seen that increase in processing temperature increased the hardness of albumin portion during thermal processing. The table also indicates that at any selected temperature, increase in duration also increased the hardness value. However, experiments conducted at 95±2^0C for duration of 30 minutes recorded a hardness value less than 13.0 and under organoleptical evaluation recorded maximum value of 8.76. Similar results were reported by Kaur *et al.* (2000) when they analyzed sensory evaluation of 'ready-to-eat egg' *Halwa.* Hence, eggs packed in pouches along with gravy and thermally processed at 95±2^0C for 30 minutes was adjudged as the optimal process.

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

Physical, biochemical and microbiological characteristics of freshly boiled egg and freshly prepared gravy used in the present study are presented in Table 4.

The results in the Table 4 indicates that freshly boiled eggs used for the present study was white in colour, as for as albumin is considered and recorded an 'L' value of 84.54 and yolk was light yellow in its appearance and recorded a 'b' value of 47.85. Karthiswaran (2004) reported significant total colour changes in milky mushrooms stored in cans which confirmed the findings in the present study.

The texture of egg was highly soft with completely solidified condition of both albumin and yolk. The albumin moisture content was about 83.07 per cent. Nakada *et al.* (1997) reported that there are 7 and 0.7 grams of free and bound moisture per gram of protein, respectively. Similarly, albumin recorded a hardness value of 9.63 N and springiness value of 0.556. The protein content of boiled egg was 13.65 per cent. The table clearly indicates that the microbial load of boiled egg was very low. Satyanarayana *et al.* (1995) stated that *Streptococcus*, *E.coli*, psychrophillic and yeast and moulds are some of the common agents that influence the microbial stability in boiled eggs.

Gravy prepared for the study was brownish red in appearance and recorded as 'b' value of 53.03 and 'a' value of 11.52. Gravy recorded a TSS value of 14.8^0 Brix and a pH value of 6.8 indicating that it is neutral in nature.

Table 3. Effects of duration of thermal processing and temperature on hardness of eggs packed along with gravy

Sr. No.	Processing temperature (°C)	Duration of processing (min)	Hardness (N)	Hedonic score
1.	90±2	25	12.59	8.32
2.	90±2	30	12.73	8.40
3.	90±2	35	12.86	8.46
4.	95±2	25	12.92	8.23
5.	95±2	30	12.98	8.76
6.	95±2	35	13.63	8.52
7.	97	25	13.69	8.44
8.	97	30	14.25	8.32
9.	97	35	15.12	8.16

Table 4. Physical, biochemical and microbiological characteristics of boiled eggs and gravy

Sr. No.	Characteristics	Values
Yolk		
1.	Colour	
	L	78.00
	a	7.54
	b	47.85
Albumin		
1.	Colour	
	L	84.54
	a	-3.65
	b	16.74
2.	Albumin Moisture content (%)	83.07
3.	Hardness (N)	9.63
4.	Springiness	0.556
5.	Microbial load	
	Bacterial load (cfu)	$1.2x10^1$
	Yeast load (cfu)	1.0
6.	Protein (%)	13.65
Gravy parameters		
1.	Colour	
	L	60.03
	a	11.52
	b	53.03
2.	TSS	14.8
3.	pH	6.8

Conclusion:

- Eggs of 5 to 20 days old and boiled for 10 minutes in boiling water recorded scored good score values and organoleptically accepted.
- Pouches containing eggs and gravy treated at a temperature of 95± 2^0C for 30 minutes was considered as optimal process based on hardness and sensory evaluation.
- The pouch size of 20 x 15 cm in size and filling ratio of 3:2 (three parts gravy in two parts of egg) was optimized based on sensory evaluation and immersion of eggs in gravy.

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