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Quality Characteristics of Egg Albumen Paneer (EAP) Incorporated with Different Binders

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ABSTRACT

Background: Egg albumen paneer (EAP) is a novel food product simulating the popular milk based paneer. The study was conducted to develop binders incorporated egg albumen paneer (EAP) and to find their effects on its quality characteristics.

Methods: Binders used were glutinous rice flour (GRF), Joha rice flour (JRF), wheat flour (WF) and oat flour (OF) in different formulations. EAP cubes were analysed for proximate composition, sensory qualities, texture profile and colour profile. Microbiological studies of the cubes stored at refrigeration temperature were enumerated for Total Viable Plate Count (TVPC), Total Psychrophilic Count (TPC) and Yeasts and Mould Counts at regular interval upto 90 days.

Result: Study revealed highest yield percentage in T_3 formulation. The proximate compositions for moisture, protein, fat and ash differs significantly among the different formulations. Analysis of Texture Profile found T_3 group with the highest value for hardness, chewiness and resilience quality while T_2 group was found for springiness and cohesiveness, while no significant difference was found for colour profile for any of the formulations. The microbial counts were within the acceptable range. It can be concluded that Egg Albumen Paneer could be prepared satisfactorily by incorporating different combinations of cereal flours.

Key words: Egg albumen, Glutinous rice flour, Joha rice flour, Oat flour, Paneer, Wheat flour.

INTRODUCTION

Besides the vegetarian and non-vegetarian group of people, there exist a sizeable population grouped as ovo-lacto-vegetarian who consumes both egg and milk but still considers themselves as vegetarian. Like milk, eggs are highly palatable and are almost routinely being included in the food menu of all the non-vegetarian and ovo-lacto vegetarian masses irrespective of their caste, creed and religion. Studies on some of the egg products *viz*., egg coated potato (Muller 1994), egg white chips containing stabilizers and flavouring (Yang *et al*., 2000), formulated fried egg (Merkle *et al*., 2003) *etc* indicates its significance as popular snack among the consumers. For those ovo-lacto-vegetarian groups such egg products including paneer made from egg albumen and egg yolk (Deepthi *et al*., 2011, 2012) would be a good option in their diet in addition to their daily milk based paneer. The fact that there is some difficulty in proper setting up of the liquid/ jelly like transparent egg albumen to prepare a paneer like product which can be well prevail over by incorporating suitable binder(s) in the form of different rice and cereal flours to prepare egg albumen paneer. The product EAP thus prepared can be used in curry and other preparations similar to paneer-in-curry, a delicacy to Indian cuisine. Further, to extend the storage life of EAP, it has been felt to convert this product as a shelf- stable dried product which can be stored conveniently for future use (Deepthi *et al*., 2012). However, the traditional milk based paneer does not have shelf stability for more than 24 hours at room temperature.

In view of the facts as stated above, it was planned to develop an Egg Albumen Paneer - a novel food product where in routinely prepared milk based paneer is being replaced by egg albumen in combination with glutinous rice flour, joha rice flour and oat flour as well as to study its quality characteristics. The aim of the study was that such egg based food products with less fat and rich dietary fibre would result in better acceptability and marketability of the product, besides, providing much needed health benefits and varieties to the ever increasing ovo-lacto vegetarian as well as non- vegetarian population.

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MATERIALS AND METHODS

A study for the production of EAP with the incorporation of different rice and cereal flours (as binders) was conducted in the Department of Livestock Products Technology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022 in the year 2018.

Product preparation

All the raw materials were carefully collected from the nearby retail market in and around Guwahati city. The formulations were made after a trial study with different percentage of the binders. The selected formulations of control and different treatment groups were like–Control (Wheat flour - 15%, Rice flour - 5%), T_1 (Glutinous rice flour -10%, Joha Rice flour - 10%), T_2 (Glutinous rice flour - 8%, Oat flour - 12%), T_3 (Joha rice flour - 8%, Oat flour - 12%) and T_4 (Glutinous rice flour - 4%, Joha rice flour - 4% and Oat flour - 12%) along with 77% of egg white, 0.5% each of mallic acid, citric acid and spice mix as preservatives and salt 1.5% for taste. Egg white was separated from the yolk manually. Batter was prepared by incorporating different proportions of the binders as per the above formulations (T_1, T_2, T_3 and T_4), followed by proper mixing with a mechanical hand blender (Make: Bajaj). It was then poured in a stainless steel mould lined with aluminium foil and cooked at 80 - 85°C for 40- 45mins in steam followed by cooling at room temperature. The loaf obtained was then cut into uniform cubes (1x1x1cm). The cubes were vacuum packaged in food grade high density polyethylene bags and stored at refrigeration temperature 5-7°C for quality studies at regular interval upto 90 days.

Percent yield

The yield percentage was determined by weighing the EAP both before and after drying.

$$\text{Yield (\%)} = \frac{\text{Wt. of EAP before drying- Weight of EAP after drying} \times 100}{\text{Weight of EAP before drying}}$$

Proximate composition

The proximate compositions of EAP for moisture, crude protein, ether extract and total ash of different experimental groups were estimated as per the methods of AOAC (2007) on dry matter basis.

Texture profile analysis (TPA)

The texture profile of EAP like hardness, springiness, cohesiveness, chewiness and resilience were evaluated by using the food texture analyzer (Make: Stable Micro Systems, Model: TA-HD plus).

Colour profile

The colour of the products were determined by using a Spectrophotometer (Make; Cary 100 UV). Colour was described as coordinates, *e.g. L*, a**and *b** (where *L** measures relative lightness, *a** relative redness, and *b** relative yellowness).

Microbiological qualities

EAP cubes were enumerated for Total Viable Plate Count (TVPC), Total Psychrophilic Count (TPC) in Plate Count Agar and Yeasts and Mould Counts in Rose Bengal Chloramphenicol Agar as per the method of Harrigan and McCance, (1976) on the day of production (1st day) and on subsequent days, *i.e.* on 5th, 10th, 15th, 20th and upto 90th day of storage.

Sensory evaluation

The sensory evaluation of EAP was done by frying the EAP cubes in vegetable oil and serving the same to a semi-trained panel of 9 judges who were habitual egg eaters and comprises of either sexes. The different eating quality parameters, *viz*. appearance, colour, flavour, texture, juiciness and overall acceptability of EAP were judged by using a 9-point hedonic scale as described by Bratzler, (1971).

Statistical analysis

The data obtained in the study was analyzed following the standard statistical method as described by Snedecor and Cochran (1994).To collect the required data for statistical analysis, a total of 5(five) batches of EAP of each formulation including the control ones were prepared. Analysis of variance (ANOVA) with Honest Significant Difference (HSD) test for mean comparison was used to highlight significant differences among the samples. Statistical tests were performed with a 5% or 1% significance level using the SPSS program version 20 (IBM Corp 2011).

RESULTS AND DISCUSSION

Yield Per cent

The yield per cent of EAP recorded in between 60.674±0.78 to 65.566±0.95 percent (Table 1). The samples of T_3 group recorded the highest yield while that of T_4 recorded the lowest. This might be due to high fiber content in oat flour (3.53-5.87% Youssef *et al.*, 2016)and relatively higher moisture content in JRF (6.58-22.68%, Roy et al., 2010) which was added at the rate of 8%, while in T_4 it was added at 4% along with GRF (7.21% moisture, Qin et al., 2016). Statistically, only the T_4sample differ significantly ($P<0.05$) in yield percentage from the other samples studied. However, the per cent yield recorded in the study was somewhat higher than those reported by Deepthi et al., (2011) who had prepared EAP by incorporating WF and Rice Flour (RF).

Proximate composition

Moisture

A significant differences *P<0.05* in the moisture content were observed between control and T_1in comparison with other formulations. The T_1 formulation recorded highest per cent (52.98±1.00) while T_2 formulation recorded lowest 44.35±0.73% (Table 1), which might be due to the incorporation of both the varieties of rice flours *i.e.*, Glutinous and Joha at 10% each in T_1 formulation, which are having a higher moisture contents of 7.21 and 6.58-22.68%, respectively (Qin *et al.*, 2016; Roy *et al.*, 2010) and also superior water binding capacity (Lee *et al.,* 2004). The lowest moisture content in T_2 group might be due to the addition of

more amount of oat flour with lower moisture content (9.96-10.47% Youssef *et al.*, 2016) as compared to the control containing rice and wheat flour with a moisture content of 12.08 and 12.67%, respectively (Thomas *et al.*, 2013; Kulkarni *et al.*, 2012).

Crude protein

The formulations (T_2, T_3 and T_4) differed significantly (P<0.05) from control and T_1 formulation in having a higher CP content (Table 1). Highest CP was recorded in T_2 and lowest in T_1 formulation. Such high percentage of CP might be ascribed to high protein content in oat flour *i.e.*, 11.61-13.62% (Youssef *et al.*, 2016) added at 12% level as compared to the control with a protein content of 5.96% in rice flour (Thomas *et al.*, 2013) and 10.55% in Wheat flour (Kulkarni *et al.*, 2012)

Crude fat

Ether extract content differed significantly between (*P<0.05*) control and T_1 as compared to other formulations of EAP. The higher Ether Extract content in T_4 formulation might be due to the incorporation of oat, joha and glutinous rice flours, which have higher fat content (7.23-8.92%, 2.03-2.88% and 0.71%, respectively- Roy *et al.*, 2010; Youssef *et al.*, 2016; Qin *et al.*, 2016) as compared to others. The lowest EE content registered in the control formulation might again be a reflection of very low fat content in wheat flour (0.94%, Kulkarni *et al.*, 2012) added at 15% level along with 5% level of rice flour (1.24% crude fat, Thomas *et al.*, 2013). A lower EE per cent was reported by Deepthi et al. (2011) for dehydrated EAP, which might be due to the differences in varieties of rice and wheat incorporated as flours in EAP preparation.

Total ash

The present study revealed a highly significant differences (*P<0.01*) between the different formulations for ash content. The highest TA per cent was registered in T_3 formulation, which might be due to the addition of oat which contains much higher percentage of ash (2-2.15% Youssef *et al.*, 2016) as compared to other flours incorporated in EAP preparation. On the other hand, the lowest TA registered in Control formulation might be due to the incorporation of rice and wheat flour both of which contains much lower percentage of TA (0.39 and 0.94%, respectively Thomas *et al.*, 2013; Kulkarni *et al.*, 2012)

However, the total ash per cent recorded in the present study was somewhat lower than those reported by Deepthi *et al*. (2011) who prepared EAP by incorporating WF and RF.

Texture profile analysis (TPA)

Hardness

A highly significant difference was found between Control and Treatment groups of EAP (*P<0.01*) (Table 2) for hardness values. Highest value found in T_3 (1.288±0.18) followed by C (0.997±0.02) and lowest in T_1 (0.404±0.04) formulation. This might be due to variation in both fiber and protein content in GRF(6.78% protein, Qin *et al*. 2016), JRF (7.7-9.9% protein, Saikia *et al*., 2012) and oat flours (11-13.62% protein, Youssef *et al*., 2016). Besides, the differences in the moisture content of these flours might have also lead to these differences. Yang *et al*. (2009) also reported that moisture content significantly affects the hardness of the food product.

Springiness

Springiness values differed significantly (*P<0.05*) for the control and treated samples, with the highest score in C

Table 1: Physico-chemical and Proximate composition of EAP incorporated with GRF, JRF and oat flour.

Parameters	C	T1	T2	T3	T4
Yield (%)	64.976±1.51^{A}	63.956±1.15^{A}	64.382±0.85^{A}	65.566±0.95^{A}	60.674±0.78^{B}
Moisture (%)	52.36±0.91^{A}	52.98±1.00^{A}	44.35±0.73^{B}	45.10±1.16^{B}	45.14±0.40^{B}
CP (%)	37.38±0.58^{B}	36.36±0.75^{B}	42.53±2.15^{A}	41.40±0.88^{A}	42.29±2.85^{A}
Fat (%)	0.77±0.02^{C}	1.08±0.15^{B}	1.21±0.17^{AB}	1.35±0.06^{A}	1.35±0.42^{A}
Total Ash (%)	2.42±0.01^{C}	2.85±0.06^{B}	2.81±0.06^{B}	3.37±0.04^{A}	2.77±0.13^{B}
L*	85.117±0.5511^{A}	86.1287±0.2341^{A}	85.2340±0.3234^{A}	85.6895±0.1964^{A}	85.5912±0.1508^{A}
a*	0.1630±0.2584^{A}	0.2782±1.1431^{A}	0.4197±1.2168^{A}	0.5567±1.1447^{A}	0.2216±1.8041^{A}
B*	17.0610±2.242^{A}	15.6636±0.4037^{A}	15.9528±0.2633^{A}	16.1068±0.1477^{A}	16.2166±0.4526^{A}

Mean with superscript bearing similar alphabet (capital) do not differ significantly.

Mean with superscript bearing different alphabet (capital) differ significantly.

Table 2: Texture Profile Analysis Scores of EAP incorporated with GRF, JRF and Oat Flour (Mean ± SE).

Treatments	C	T1	T2	T3	T4
Hardness	0.997±0.02^{AB}	0.404±0.04^{C}	0.914±0.19^{AB}	1.288±0.18^{A}	0.686±0.07^{BC}
Springiness	0.577±0.07^{A}	0.325±0.02^{B}	0.403±0.03^{AB}	0.392±0.07^{B}	0.479±0.05^{AB}
Cohesiveness	0.713±0.05^{A}	0.624±0.05^{A}	0.715±0.05^{A}	0.631±0.08^{A}	0.537±0.08^{A}
Chewiness	0.370±0.05^{A}	0.088±0.00^{C}	0.293±0.10^{AB}	0.412±0.06^{A}	0.164±0.01^{B}
Resilience	0.382±0.07^{A}	0.386±0.07^{A}	0.461±0.13^{A}	0.506±0.15^{A}	0.332±0.10^{A}

Mean with superscript bearing similar alphabet (capital) do not differ significantly.

Mean with superscript bearing different alphabet (capital) differ significantly.

(0.577±0.07) followed by T_4 (0.479±0.05) and the lowest in T_1 (0.325±0.02) formulations. Though T_1 formulation recorded higher moisture per cent yet the springiness value was lowest in T_1 formulation. This might be due to the presence of higher fiber content in GRF. The highest springiness recorded in C formulation might be ascribed to lower fiber and also moisture content in WF. Springiness behavior varies significantly with the processing techniques and could be correlated with the influence of moisture in the product (Hsu and Yu, 1999).

Cohesiveness

No significant differences between control and treatment groups of EAP were found for cohesiveness. Mean value was highest in T_2 (0.715±0.05) and lowest in T_4 (0.537±0.08). Even though T_2 registered a low moisture content, the highest cohesiveness score registered by it might be due to high fiber content in GRF that acted as strong binding agent. The C group exhibited second highest cohesiveness character next to T_1 and this could be due to higher moisture content as compared to T_2 formulation.

Chewiness

Chewiness values differed significantly *(P<0.05)* between control and treated groups. The formulation of T_3 (0.412±0.06) was found to be the highest and that of T_1 was the lowest (0.088±0.01). This might be due to the presence of low moisture content in T_3 than that of T_1.

Resilience

For resilience no significant differences was found between control and treated groups. Mean value was highest for T_3 (0.506±0.15) and lowest in T_4 (0.332±0.10) group which might be due to variations in both fiber and protein content in GRF, JRF and oat flours. Besides, differences in the moisture content of these flours might have also lead to the differences.

Colour profile

No significant differences were found among the treatment and control samples for *L** value (Lightness or Darkness), *a*m(Redness or Greenness) and *b**Yellowness or Blueness. Nevertheless, the highest mean score for *L** was recorded in T_1 (86.1287±0.2341) and the lowest in C (85.1177±0.5511) group. For *a** score, T_3 group recorded the highest one (0.5567±0.1447) and control group with the lowest (0.1630±0.2584). The score for *b** was highest in control group (17.0610±2.242) and lowest in T_1 group (15.6636±0.4037). The changes in color attributes of the products might have influenced by the processing methods (Pesek and Wilson, 1986), degree of exposure to light (Kim *et al*., 2002) and ingredients interactions (Osuna-Garcia et al., 1997).

Microbiological qualities

The studies on microbiological qualities of EAP revealed no growth of colonies in Total Viable Plate count (TVPC), Total Psychrophillic Count (TPC) and also for Yeast and Moulds up to 90th day of storage. This might be due to the presence of albumen protein i.e.conalbumen in egg albumen that binds iron making it unavailable for bacterial growth and multiplication (Gram positive organisms). The enzyme lysozome of egg albumen also have an anti-bacterial property (Wang and Shelef, 1991).Addition of mallic acid in EAP preparation have anti-fungal property inhibiting the growth of yeast and moulds.

Deepthi *et al*. (2011) also evaluated the microbiological quality of EAP prepared by incorporation of Wheat flour (WF) and Rice flour (RF) and stored for 6 months at 27±2°C. They recorded Standard Plate Count (SPC) and Yeast & Mould counts fluctuate within the range of 0.90±0.05 to 3.25±0.05 and 0.84±0.04 to 2.52±0.33 log cfu/g respectively during the storage period. This discrepancy might be primarily due to the difference in the storage temperature of EAP which was 5-7°C in the present study besides, differences in the quality of ingredients used (GRF and JRF) and their incorporation levels in EAP preparation.

Sensory evaluation

Though, no significant differences were observed in respect of appearance, colour, flavour, texture and overall acceptability scores among the control and treatment groups (Table 3) the control group of EAP (incorporation of 15% wheat flour and 5% rice flour) recorded the lowest sensory evaluation scores for all the eating quality parameters. The relatively better appearance and colour scores recorded in T_1 formulation (GRF 10% and JRF 10%) might be due to the correct matching of colours of rice flours with that of Egg Albumen. The T_3 formulation with better flavour scores might be attributed to incorporation of JRF alongwith oat flour in EAP preparation. Highest texture score in T_2 formulation signifies more fineness of the product. The highest overall acceptability score in T_3 formulation might be primarily related to its superior flavour quality imparted by incorporation of JRF.

Table 3: Sensory Evaluation Scores of EAP incorporated with GRF, JRF and Oat Flour (Mean±SE).

Treatment	Eating quality traits				Overall
	Appearance	Colour	Flavour	Texture	acceptibility
C	7.50±0.24	7.36±0.33	7.25±0.13	7.37±0.21	7.51±0.19
T_1	7.63±0.34	7.83±0.13	7.55±0.13	7.50±0.29	7.82±0.37
T_2	7.54±0.09	7.54±0.14	7.65±0.16	7.82±0.25	7.77±0.28
T_3	7.57±0.17	7.62±0.15	7.74±0.10	7.46±0.16	7.88±0.25
T_4	7.52±0.04	7.51±0.07	7.53±0.08	7.62±0.12	7.81±0.24

CONCLUSION

Based on the results obtained in the study it might be concluded that, Egg Albumen Paneer (EAP) could be prepared satisfactorily by incorporating GRF, JRF and Oat flour besides WF and RF. Addition of rice flour and oat flour produced superior quality of EAP as compared to wheat flour. Taking into account it's higher nutritive value, longer shelf life and desirable eating qualities, EAP could be prepared and marketed with added advantage as compared to milk based paneer particularly for those who are ovo-lacto vegetarian or non-vegetarian in their food habit.

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