EVALUATION OF THE EFFECT OF TEMPERATURE FOR READY TO EAT DEEP FRIED ETHNIC SNACKS ALUCHURE MADE BY USING POTATO STARCH-CHICK PEA'S FLOUR-RICE FLAKE AND PEA NUT

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Abstract: *aluchure is an ethnic ready to eat complementary snacks and produced in large quantities in Bangladesh, which are one of the major sources of protein, fat, fiber and carbohydrate respectively. The study was proposed on developed high energy complementary snacks from the blends of chick pea flour and potato starch using deep fried cooking. Cultivars of chick pea was selected and milled into flours. Using the response surface methodology, the blends of potato starch and cowpea flours at 70:30 was prepared batter for aluchure noodles using mechanical press type extrusion machine. The suitable hardness of aluchure fried at 170° C for 40 min as compared to higher temperature (180°C) and highest mean sensory scores for color (7.14), fried odor (7.21) and overall quality (7.21). The study showed that frying of aluchure up to 180 °C level for 40 min was the best sensory acceptability. The deep frying temperature affected the recovery of batter noodles ($p<0.001$) may be due to higher starch in case of sample frying at 170 and 180°C. Also the study revealed that fried cooking parameters used in this study significantly affected the frying parameters ($p<0.05$).*

Keywords: *Chick pea, potato starch, deep fry cooking, sensory properties, Aluchure*

Introduction

Chick peas are a good source of protein and carbohydrate that can easily be processed into flours and blended to produce food of high protein quality with high nutritional value. Besides being a good source of B-vitamins, chick pea contains substantial quantities of lysine[1] and when blended with potato starch, it produced blends with complementary amino-acid profiles and improved the nutritional quality[2]. Ethnic snacks have occupied unique share due to its excellent texture and taste. Chick peas is a top most legumes among five member as per production[3].It is used for the preparation of traditional foods[4] and as ingredients of bakery products, and infant foods[5]. Composition of chick peas is 17.5% protein, 2.7% fat and 2.1 % minerals[6]. Well known food products using chick peas flour is Chanachure, Sev, Brondi, and Chakli[7] in South Asia. Aluchure is a ready-to-eat ethnic snacks food of Bangladesh and most popular in west Bengal, India. It is prepared from flour of chick peas, potato starch, rice flakes, hot spices powder, vegetable oil, baking agent, and pea nut, or legumes only or, combination of cereal and legumes. It is a convenient food product, containing digestible dietary constituents of

vital importance. Frying which is a simple and more commonly used household and village level technology, pre-cooks the ingredients used in food grains and other mixes and increases shelf life and acceptability of the products[8]. Roasting improves the flavor, texture and nutritive value of the product[9] and eliminates most of anti-nutritional or toxic effects of legumes, partially or wholly[10]. Amongst various legumes, such as Bengal gram, cow peas, potato starch, chick peas and rice flakes are the most liked grain for making *Aluchure.* Earlier *ready to eat Aluchure was* considered as snack food of all ages but it is gaining popularity amongst all because of its protein value and suitability of this product for diabetics due to lower glycemic index of Bengal gram and barley[11]. Anonymous[12] developed an acceptable quality product from roasted flour mixture using wheat, Bengal gram, defatted soy flour, groundnut and jiggery called *Amirtham*. Proportions used for preparing this product were 50% wheat, 25% Bengal gram, 8.25% defatted soy flour and 16.66% pea nut. Cow peas, being less expensive, but rich source of good quality 30% protein has been recognized as a vital ingredient of protein enrichment for ready to eat snacks. Several workers have explored the possibilities of using different legumes flour with potato starch to prepare a variety of food products of Bangladeshi taste such as spicy and crispy snacks, baby foods, vegetable puree, beverages and bakery products[13, 14, 15] but information on optimum frying temperature and time combination for potato starch for incorporating in Aluchure is not cited in the literature. As Aluchure is getting popular amongst diabetics, incorporation of potato starch in *Aluchure* in acceptable proportion will not only enhance the protein value of the product but also provide benefits of health promoting phytochemicals at an economic price. The present study was conducted with the objective to evaluate frying temperature and time combination of potato starch for making *Aluchure* formulations based on potato starch, chick peas flour, rice flakes , pea nut, and other additives.

Materials and Methods

Materials: De-hulled chick pea, natural potato starch, rice flakes, pea nut, spices, vegetable oil, and additives such as $NaHCO_3$ were procured from local market in Bangladesh. Natural potato starch – chick peas flour with moisture content of 7.40% (d.b.) was used for batter (moisture 21% d.b) preparation.

Milling : Dry and clean de-hulled chick pea flour was prepared using local milling crusher @ 200n mesh size; and a mixture of dried zinger, red chili , turmeric, cumin , maize, black pepper, white pepper, bay leaf and coriander were powdered using jaw crusher machine. All the crushed powder was filtered using mesh jar type filtration equipment after dry and cold phase.

Frying and final steps for finished product: Sample batter was fired in a continuous fryer (Figure 1) with a 200 liter capacity. The vegetable oil was heated to 180^0C. For deep-fat frying studies, coarse yellow pea flour and potato starch, salt, fiber, and baking agent were used. The standardized formula (batter) used in aluchure noodles preparation which included 35% chick pea flour,20% potato starch, 1.2 % salt, 0.2 % sodium bi carbonate, 0.01% emulsifier, and 14% water (Table 1). The dry ingredients were mixed in the batch mixer bowl before addition of water. The mixture was whipped in the

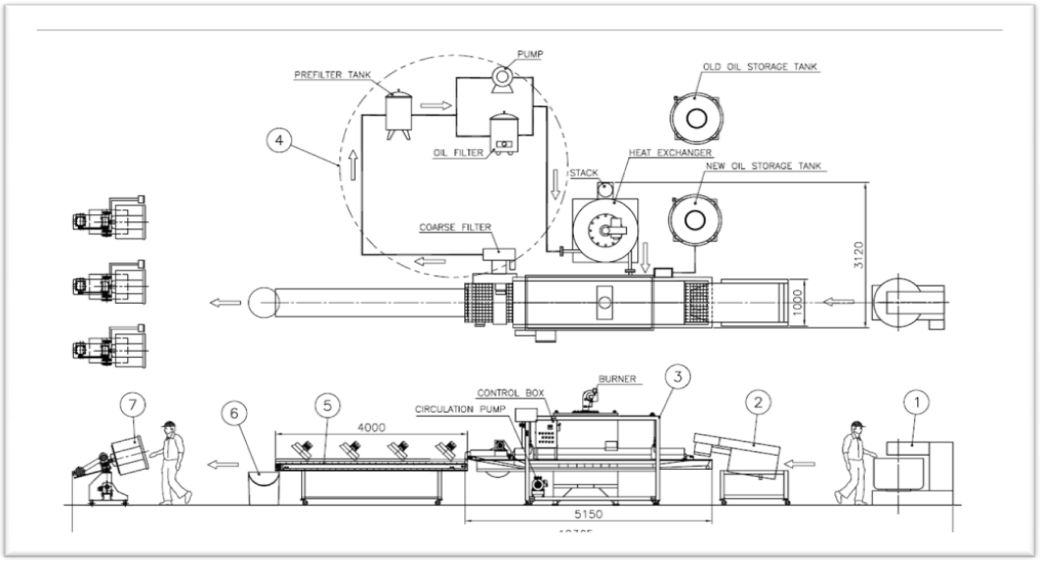
kneader type mixer at speed 750 rpm for 12 min with addition of measured water. The batter was dropped by auto speed control batter noodles making press extrusion device into the continuous fryer and fried until *Aluchure noodles* formed a golden brown crust (20-40 min). The aluchure noodles were turned three times to ensure even cooking. The fried *noodles were* conveyed for de-oiled through fitted centrifuge machine. Other ingredients as 2.35% spice powder, 5% roasted pea nut, 5% rice flakes, 4% green peas and 4% fried lentils were mixed with the fried noodles in trammel drum and then packed by multi head pouching machine using 67 µn packaging materials. Proximate analysis [17], color (L*, a* and b* values) and textural properties were determined after 24 h of frying.

The Aluchure sample was evaluated for different sensory attributes to find out the best accepted chick peas flour-potato starch, prepared from de-hulled chick peas and natural potato starch at 180ºC temperature and 20,30 and 40 minute frying time (Figure 1) .

Table 1. Formulation for Aluchure Sample

Sl No	Ingredients	Quantity in kg	Ingredients	Quantity in kg
1	Chick peas flour	45	Green peas, fried	5
2	Potato Starch ,Natural	20	Lentils, fried	5
3	Rice flakes	7	Palm oil, RBD	34
4	Peanut, roasted	5	Spices powder, hot, salt, Baking agent	4.35

Figure 1: Schematic diagram of Aluchure Production line



1.Dough Mixer, 2. Extruder,3. Automatic Continuous Fryer, 4. Fine oil Filtration, 5. Cooling Conveyor, 6. Storage trays, 7. Batch type seasoning mixer

Textural Properties: Textural properties of sample such as hardness (h), toughness (Ta) and average rupture force (Rf) were measured using Texture Analyzer (TA) TA-HDi, Stable Micro systems. The TA setting were: Mode-measure force in compression, option-return to start, pre test speed-3 mm sec^{-1}, test speed-1 mm sec^{-1}, post test speed-10 mm sec^{-1}, distance-3 mm, stainless steel cylinder probe-5 mm diameter and 50 kg load cell. Textural properties were measured for 10 number representative noodles under frying condition. During the test, the graph was drawn between force and distance as the result of the force resisted by the noodles sample against the probe of texture analyzer with the help of software (Texture Expert Exeed ^{TM}, MS Windows). The maximum force experienced by the probe is considered as hardness and the area under the maximum force on the graph is considered as toughness of the product mass. The average force experienced by the probe throughout the test is considered as average rupture force of the sample.

Color Determination: Color (L*, a* and b* values) of the noodles sample was estimated using Handy Colorimeter NR-3000. L* is known as the lightness and extends from 0 (black) to 100 (white). The other two coordinates a* and b* represents redness (+ a) to greenness (-a) and yellowness (+ b) to blueness (-b), respectively. Hue angle (h°) is the attribute of color by means of which the color is perceived. Chroma (C*) is the attribute of color used to indicate the degree of departure of the color from gray of the same lightness. h° and C* are computed by using the equations 1& 2.

$$\mathbf{h}^\circ = \tan^{-1}(b/a) \quad (1)$$

$$C^* = a^2+b^2 \text{ where } a = a^*, b = b^* \quad (2)$$

Sensory Evaluation: Aluchure sample was evaluated in ready to eat form, for different sensory attributes by a panel of trained students of the nutrition and food engineering department under Daffodil International University. The Aluchure was prepared with 15 gm in each tasting tray. Sensory attributes like color, hardness, toughness, odor, and overall acceptability for sample assessed using nine point hedonic scale[18,19]. Sensory properties of Aluchure noodles made from 35% chick pea flour showed height color as some surface frying occurs before interior was fried, which also lead to more firm , sandy texture. The force required for compression of sample together at a time support showed a higher value in table 2.

Statistical Analysis: Analysis of variance and polynomial regression for the data of the study were computed using Statistica 7.1 and ANOVA methods[20].

Result

Frying has a significant impact on the overall quality of the final product i.e., *Aluchure*. The deep frying odor, a most important quality of *Aluchure* is basically depends on the frying temperature and time combination. Hence, frying temperature and time

combination is of great importance in processing for making *Aluchure*. It is observed that moisture content of batter decreased with increase in both frying temperature as well as time, which is obvious and expected. In general, batter noodles size increased with increase in frying temperature and time except for 20 -40 min. The noodles were fried at 170 - 180° C for 20 min, 30 min and 40 min, in this experiment. The expansion in noodles size is attributed to start of puffing of shape at high temperature and time combination. The recovery of noodles was in the range of 79.05 to 81.28%. The deep frying temperature affected the recovery of batter noodles ($p<0.001$), may be due to higher starch in case of sample frying at 170 and 180° C. Textural properties of the Aluchure sample is very important because energy requirement for mixing may be in proportion to the noodles hardness. Various studies indicated the affect of hardness on particle size of milled chick peas and energy consumption in milling[21]. Batter noodles hardness was affected by noodle size, direction of applied force, moisture content, chemical composition and heat treatment[22,23]. From the Fig. 2, it is observed that in general, hardness of batter noodles decreased with increase in frying temperature and time of frying except at 180° C for 40 minutes time. The reason for the increase in hardness at 170 and 180° C for 40 minutes, temperature and time combination may be due to drastic reduction in moisture content of the batter that made the noodles harder as also observed in case of potato –chick peas[24]. The similar trend was observed in toughness and average rupture force of fried aluchure sample (Table 2 & Figure 2).

Figure 2: Effect of noodles frying on hardness, toughness and average rupture force (ARF) of Aluchure at 180 and 200°C temperature for 20, 30 and 40 mins

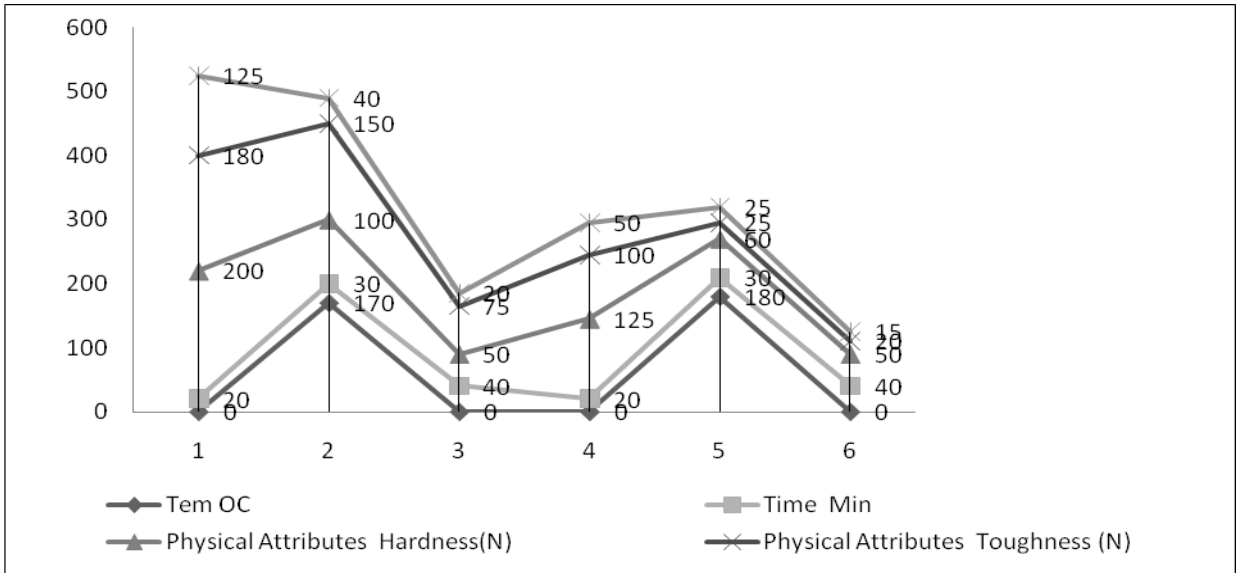
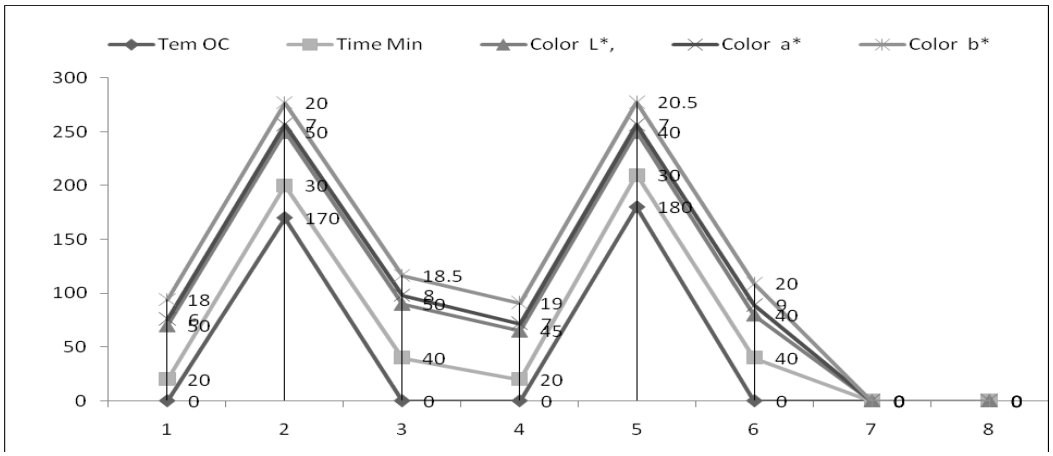


Figure 3: Effect of Frying on color (L*, a* and b* values) of noodles fried at 180, and 200°C for20, 30 and 40 min



$$Ts = 2307.104-15.586\ T+0.034\ T^2-15.937\ t+0.12\ t^2 \quad (4)$$

Multiple R = 0.87

$$ARF = 1439.83-10.288\ T+0.023\ T^2-8.344\ t+0.061\ t^2 \quad (5)$$

Multiple R = 0.92

Where, H = hardness; Ts = toughness; ARF = average rupture force; T = temperature; t = time

Table 2: Analysis of variance for textural properties and color of Fried Aluchure

Parameters	Source of Variation	df	ss	Ms	f-ratio
Textural Properties	Frying Temperature and time of fried Aluchure	N=n-1			
Hardness(N)	Temp in ^{O}C	1	52905	26453	134.57***
	Time in Min	1	32338	16170	82.32***
Toughness(N)	Temp in ^{O}C	1	84621	42310	64.81***
	Time in Min	1	44720	22360	34.32***
ARF(N)	Temp in ^{O}C	1	26803	13407	99.12***
	Time in Min	1	17860	8803	65.33***
COLOR					
L* Values	Temp in ^{O}C	1	383.3	191.7	172.22***
	Time in Min	1	0.59	0.29	0.62^{ns}
a * Values	Temp in ^{O}C	1	12.87	6.45	35.9***
	Time in Min	1	8.19	4.09	22.9 **
b*Values	Temp in ^{O}C	1	5.02	2.26	7.4 **
	Time in Min	1	1.88	0.99	2.62^{ns}

***p<0.001; **p<0.01; ^{ns} = non-significant

Figure 4. Effect of frying on mean sensory scores for different attributed of Aluchure

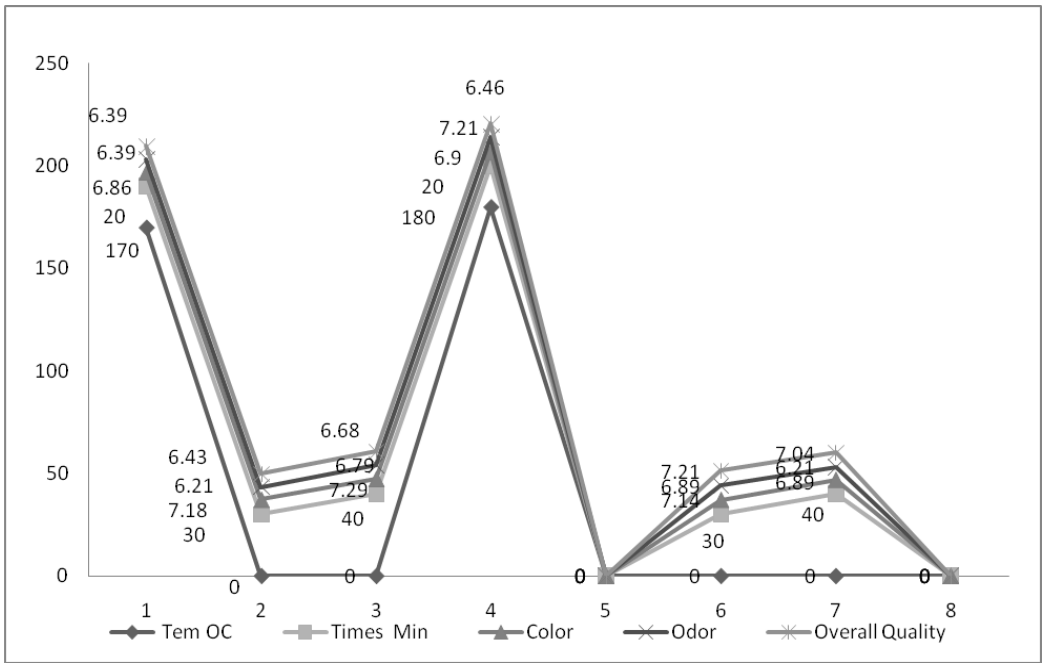


Table 3: Analysis of variance for different sensory attributes for Aluchure sample

Sensory Attributes	Source of variation	df	ss	Mss	F-ratio
Color	Judges	6	0.192	0.032	0.48^{ns}
	Aluchure sample	8	56.657	7.082	105.63***
Frying odor	Judges	6	0.762	0.127	1.88^{ns}
	Aluchure sample	8	27.929	3.491	51.75***
Total quality	Judges	6	0.665	0.111	1.17^{ns}
	Aluchure sample	8	17.107	2.138	22.65***

***p<0.001; ^{ns} = non-significant

The color of any food product is the first attribute that affects the decision of consumer for purchasing or consuming the food. Frying, in general, affected the color of Aluchure batter. In general, L* value of fried noodles decreased while a* values increased with increased frying temperature that resulted in the darkening of the noodles at higher temperatures and poor acceptability. Whereas, increase in frying time at 170 ° C did not brought significant changes in L*, a* and b* values but at 180° C, L* values slightly decreased with increased frying time (Table 3 and Figure 3). The effect of temperature and time of frying on hue angle (h°) and chroma (C*) for fried noodles is presented in non-linear polynomial regression equations and after deleting the non-significant variable (time or temperature as the case may be), the regression equation can be written as:

$h° = -57.4385+1.5956\ T-0.0043\ T^2$ (5)
Multiple R = 0.92

$C^* = -52.5473+0.6311\ T+0.3419\ t$ (6)
Multiple R = 0.87

Discussion

The effect of temperature and time of frying on batter noodles hardness, toughness and average rupture force is presented in non-linear polynomial regression equations. Both the independent variable i.e., temperature and time were considered for computation of coefficient of determination.

The frying temperature and time affected the sensory quality of batter (Table 3). The mean sensory scores for all the attributes for fried aluchure sample, prepared from the batter noodles at 170 ° C for different time combination and 180 ° C for 40 minutes were more than the minimum acceptable score of 5 (Table 3 & Figure 4). The results thus indicated that the sample of fried Aluchure was accepted by the panelist with highest sensory scores for frying odor and overall quality (7.21) at 180° C for 40min. The mean sensory scores of Aluchure formulation for odor (6.21) and overall acceptability were in the range of 6.68 (Figure 4). The quality parameters v_{iz}., 2%moisture, 32% fat content,14% protein ,50% carbohydrate , 1.87% fiber and energy 544 kcal /100 gm.

Conclusion

The investigation so far revealed that the blending of Potato starch and chickpea has the potential of producing enriched complementary ready to eat snacks for all time snacks food in Bangladesh. Frying of Aluchure at different time - temperature combination affected the physical properties and sensory acceptability of the product. In general, hardness of aluchure increased with increase in frying temperature from 170 to 180° C. And fried cooking parameters significantly affected the frying parameters (p<0.05).

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