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Development and Evaluation of Ready-To-Eat Extruded puff Product using Water Chestnut Flour

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Abstract: *Rice, corn and water chestnut (Trapa natans) were used for prepared extruded puff product by twin screw extruder at a different level (10%, 20%, and 30%) and compare with the control sample. The effect of blending levels (10%, 20%, and 30%) of water chestnut on the physicochemical properties and texture properties were examined. Extruded puff product was prepared by twin screw extruder with the addition of 15 ml of water. The sensory score of 10% extruded puff product found best with the color, flavor, taste, texture and overall acceptability respectively.*

Keywords: *Trapa natans, twin screw extruder, sensory score*

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I. Introduction

Over the decades, changes in the human lifestyle and more interest towards demands of the snack foods change the scenario of the food market relative to products types. Now a day, demand and selection of the snack foods by the consumers are based on its taste and flavors' along with the nutritional properties of its components. Food industries identify the demands of the consumer's point of view and they focused on this perspective. Extrusion technology is a widely accepted food processing technology applied to the vast variety of food products e.g., snacks, textured protein products, and ready-to-eat extruded puff products. It's a high temperature and short time process for the production of nutritious food products with minimal loss of its nutritional properties e.g., amino acids and vitamins. Generally, an extruder consists of tightly fitted screw rotating within a stationary barrel. Ingredients enter the screw with pre-optimized conditions, where they mixed with heating and conveyed to yield an extruded product [1]. Advantages of the extrusion technology are to process a range of different products with minimal changes in the ingredients and processing conditions on the same instrument. Extrusion technology offers the advantage to produce innovative snack food products which can attain the attention of the consumers along with the manufactures ease of production, quality control and economics [2]. Water chestnut popularly known as Singhara in India is an aquatic angiosperm. It belongs to the family Trapaceae, one of the free-floating plants, Grown in shallow water fields, ponds or swampy lands in tropical and sub-tropical countries [3].

The demand for new products having intricate shape and small size is beyond the capability of single-screw extruders. Twin-screw extruders can fill some of these needs. The term 'twin-screw' applies to extruders with two screws of equal length placed inside the same barrel. Twins screw extruders are more complicated than single screw extruders, but at the same time provide much flexibility and better processing control. These extruders significantly increased the variety of products that can be made using extrusion technology [4, 5]. It's reported that water chestnut (*Trapa natans*) show many pharmacological activities like as: analgesic, anti-inflammatory, anti-diabetic and antimicrobial [6]. Fruit of the *T. natans* is covered with a thick jet-black outer pericarp shaped like a horn. Its main root system adheres in the muddy soils at the bottom of the pond and it is connected with floating leaves by herbaceous stems in the water body. It is grown in India mainly for consumption as a food either in the form of vegetable, dried to make flour to prepare flattened bread called chapatti.

II. Material and Methods

2.1 Procurement of raw materials

Corn flour (*Zia maize*), Rice flour (*Oryza sativa*), and water chestnut flour (*Trapa natans*) free from mechanical or pathological impurities were procured from local market of Jhansi.

2.2 Evaluation of physicochemical and chemical composition of raw materials

Physicochemical properties (moisture content and ash value) and chemical composition (carbohydrate, protein, fiber, and fat) of raw materials were evaluated according to standard internationally approved methods described

by Association of Official Analytical Chemists (AOAC) for the assessment of the quality of raw materials. Moisture content was evaluated as per AOAC-925.10 method; ash value was evaluated as per AOAC- 923.03 method; protein content was determined as per (IS:7219:1973) Kjeldhal method, final protein content was obtained by using the conversion factor of 6.25; Dietary fiber was measured gravimetrically as per IS:11062 and AOAC-991.43; fat content was determined by titrimetry as per AOAC 939.05.

2.3 Sample preparation

Four samples were prepared using one as control (C) containing corn flour 60% and rice flour 40%, sample two (C2) contain corn 54%, rice 36% and water chestnut 10%, sample three (C3) contain corn flour 48%, rice flour 32% and water chestnut flour 20%, sample four (C4) contain corn flour 42% rice flour 28% and water chestnut 30%. Each sample was mixed properly with 12.5 gm salt and 15 ml of water and passed through 10 mesh size sieve to improve mixing.

2.4 Nutritional composition of different blends

Nutritional composition of different blends (C, C1, C2, and C3) was evaluated according to standard internationally approved methods described by Association of Analytical Chemists (AOAC). Moisture content was evaluated as per AOAC-925.10 method; ash value was evaluated as per AOAC- 923.03 method; protein content was determined as per IS:7219:1973 Kjeldhal method, final protein content was obtained by using the conversion factor of 6.25; Dietary fiber was measured gravimetrically as per IS:11062 and AOAC-991.43; fat content was determined by titrimetry as per AOAC 939.05.[7, 8].

2.5 Evaluation of pasting properties of different blends

For the analysis of pasting properties of different blends (C, C1, C2, C3, and C4) Rapid Visco Analyzer (RVA) was used. Using RVA, blend starch slurry was cooked at 95ºC then cooled to 65ºC, and its viscosity was measured. The pasting temperature 65ºC was used to rapidly stabilize viscosity and minimize retrogradation.

2.6 Development of the extruded puff product (Extrusion)

BTPL lab model twin screw extruder (Basic Technology Pvt. Ltd. Kolkata Model No-002-13-14) was used for the development of the puff product.

Main switch on

↓

Check line voltage (350-450) in all three phase

↓

Set heater I and II (110 and 60^0 C)

↓

Set cutter switch on (60-70 rpm)

↓

Check feeder speed (Set to minimum)

↓

Feeder switch on

↓

Set extrusion rpm (250-400)

↓

When heater I is 110^0C, switch on extruder

↓

Press start (Green button)

↓

Set feeder rpm between 15-20

↓

Check extruder in idle function (Check if dye is properly closed)

↓

Fix dye with dye opener wrench

↓

Close the lid

↓

Add ingredients, first feed moist feed around 20 g (moisture 25-30%) then add actual feed

↓

Start extruder for extrusion

2.7 Texture analysis of prepared extruded puff products

The texture analysis was carried out with the help of stable microsystem texture analysis TA-XT2i. It was used in cutting mode to record the required force to break extruded samples. The extruded sample was placed on the plate transversely over a metal sheet support and operated in the compression mode with the help of a probe. The probe distance was fixed to 3 mm to complete a test.

2.8 Evaluation of sensory characteristics of prepared extruded puff product

Color, texture, aroma, taste and overall acceptability of extruded puff product were organoleptically evaluated by 10 semi-trained panelists of Department of Food Technology, Bundelkhand University, Jhansi. The panelists had no previous knowledge of the research objectives. Sensory evaluation was carried out by 9 point hedonic scale. Sensory scores for each attribute were recorded and mean scores were calculated. These mean scores represented the panel's judgment about the sensory quality of the extruded puff product.

III. Result & Discussion

3.1 Physicochemical and chemical composition of raw materials

Physicochemical and chemical compositions of raw materials were evaluated according to standard internationally approved methods described by Association of Analytical Chemists (AOAC) for the assessment of the physicochemical and chemical quality of different flours.

Table 1: Proximate physicochemical and chemical composition of different flours

Constituents	Corn flour	Rice flour	Water chestnut flour
Carbohydrate (%)	70.52±0.14	80.36±0.72	83.13±0.36
Protein (%)	10.66±0.04	07.40±0.11	03.10±0.24
Fat (%)	04.40±0.37	00.87±0.80	0.32±0.12
Ash (%)	01.62±0.09	00.70±0.04	02.42±0.58
Moisture (%)	06.60±0.05	11.02±0.06	09.00±0.11
Crude fiber (%)	02.23±0.13	0.71±0.600	00.12±0.22

Note: All values represented as mean ± SD (Standard deviation) n=3; data were analyzed by one-way ANOVA (Analysis of variance) using SPSS 16.00 software

3.2 Nutritional composition of different blends

The proximate composition of the different blends to prepare the extruded puff product is given in Table 2. And nutritional composition of different blends is given in Table 3.

Table 2: Composition of different blends (in g)

Ingredients	Blends			
	C	C1	C2	C3
Corn flour	150	135	120	105
Rice flour	100	90	80	70
Water chestnut flour	-	25	50	75
Salt	12.5	12.5	12.5	12.5
Water	15	15	15	15

Note: Total quantity of each sample prepared was 250 g

Table 3: Nutritional composition of different blends

Sample	Constituents					
	Carbohydrate (%)	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Crude fiber (%)
C	74.34±0.12	09.44±0.77	03.20±0.07	01.37±0.07	10.24±0.5	01.70±0.10
C1	75.24±0.13	08±73.012	02.79±0.12	01.19±0.03	09.58±0.10	01.63±0.90
C2	76.11±0.11	08.18±0.03	02.25±0.10	02.88±0.06	08.54±0.14	01.41±0.14
C3	76.88±0.60	07.58±0.05	02.30±0.50	03.6±0.06	07.54±0.64	01.49±0.03

Note: All values represented as mean ± SD (Standard deviation) n=3; data were analyzed by one-way ANOVA (Analysis of variance) using SPSS 16.00 software

3.3 Pasting properties of different blends

This test measure flour starch properties for Asian noodle products, flour of medium to high peak viscosity is preferred because it gives better texture characteristics. The RVA can also be used to determine the stirring number, which is related to sprout damage. A stirring number test is performed to measure enzyme

activity that results from sprout damage. Starch slurry is cooked at 95ºC then cooled to 65ºC, and its viscosity measured, using an RVA. The paste temp of 65ºC is used to rapidly stabilize viscosity and minimize retrogradation (Table 4 and Figure 1).

Table 4: RVA analysis of Extruded puff products

Sample	Peak Viscosity (cP)	Hold Viscosity (cP)	Final Viscosity (cP)
C	579	549	1371
C1	959	774	2152
C2	1138	858	2402
C3	1249	1087	2898

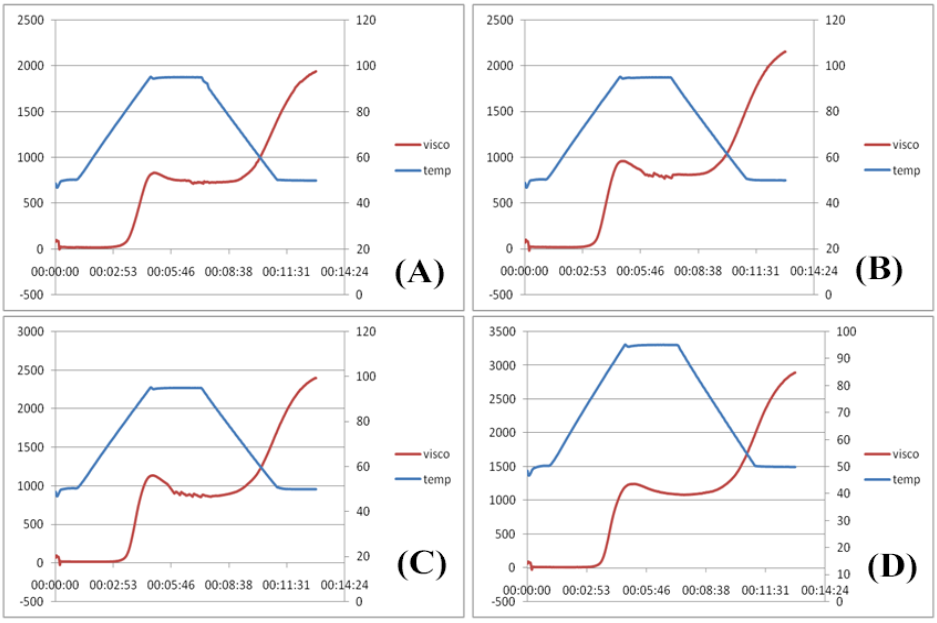

Fig 1. Graphical representation of rapid visco analyzers, (A) RVA Graph of control sample (C), (B) RVA Graph of 10% Water chestnut (C1), (C) RVA Graph of 20% Water chestnut (C2), (D) RVA Graph of 30% Water chestnut (C3)

3.4 Texture analysis of prepared extruded puff products

It was found that the cutting strength of the extruded product was increasing means extruded product becomes harder with an increase of water chestnut flour (Figure 2).

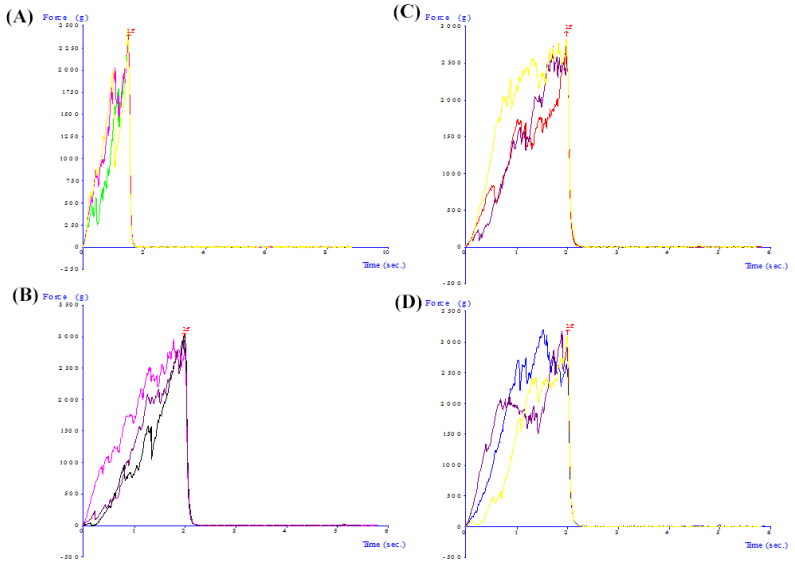

Fig 2. Graphical representation of texture analysis, (A) Control sample (C), (B) 10% Water chestnut (C1), (C) 20% Water chestnut (C2), (D) 30% Water chestnut (C3)

3.5 Sensory characteristics of prepared extruded puff products

Sensory evaluation was carried out as per 9 point hedonic scale (Table 5). Among the four extruded puff products (C, C1, C2, and C3), the second product (C1) had highest overall acceptability (score=7.9±0.70) as compared to the control (C) and other samples (C2 and C3). Overall sensory profile of the product C2 indicated the desirable organoleptic properties which suitably reflected its acceptability. Physical analysis of extruded puff product samples revealed that the increasing level of water chestnut flour resulted in product with a darker color.

Table 5: Sensory scores of Extruded puff products

Sample	Sensory Parameters				Overall acceptability
	Color	Texture	Aroma	Taste	
C	5.3±1.06	6.8±1.35	6.6±0.70	6.5±1.50	6.3±0.96
C1	8.2±0.63	7.9±1.29	7.5±0.97	7.6±1.07	7.9±0.70
C2	6.6±1.35	7.0±0.67	6.2±1.03	7.4±0.84	6.7±0.72
C3	5.2±0.95	6.2±1.23	7.5±1.08	6.9±1.59	6.5±0.92

Note: All values represented as mean ± SD (Standard deviation) n=3; data were analyzed by one-way ANOVA (Analysis of variance) using SPSS 16.00 software

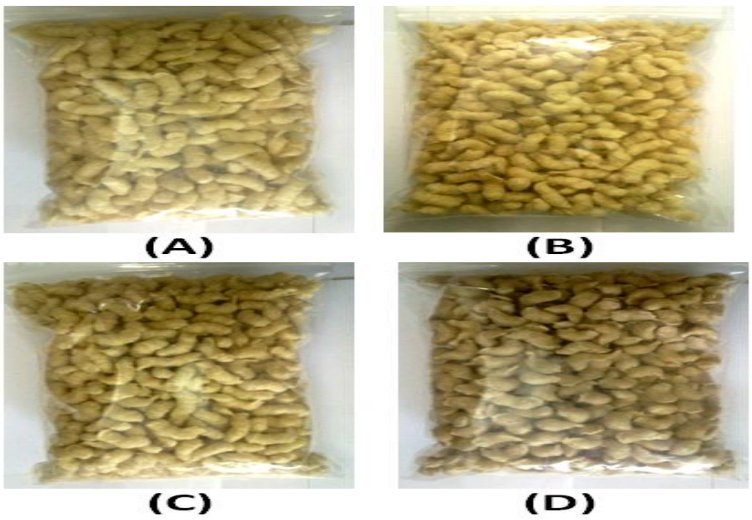

Fig 3. RTE extruded puff products developed using different composition of Water Chestnut Flour, (A) Control sample (C), (B) 10% Water chestnut (C1), (C) 20% Water chestnut (C2), (D) 30% Water chestnut (C3)

IV. Conclusion

Extruded puff product food made from twin screw extruder. Usually composed of maize, rice flour, salt, and water. The present study was undertaken to incorporate water chestnut flour there rich in high pH range (6.7-8.2) and also be content high minerals (Ca, P, Fe, Cu, Mn, Na, K) there also incorporated in extruded puff product having the quality of essential minerals. The flour of water chestnut contains 16% starch and 2% protein. The plant water chestnut (Trapa natans) has also been evaluated for various activities such as analgesic, anti-inflammatory anti-diabetic and anti-microbial. Extruded puff product having contained 10% water chestnut flour increased the essential minerals, starch, and protein. These level of extruded puff product incorporated with water chestnut was highly acceptable with respect to sensory attributes. On the basis of physicochemical, nutritional properties and sensory qualities, Extruded puff products with containing 10% water chestnut flour (Sample C1) resulted in better quality having more nutritional elements and highest overall acceptability. These types of extruded puff products can be used as nutritional RTE (Ready to Eat) food for low-income group in developing countries and for health conscious people.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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