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# Proximate composition and organoleptic evaluation of extruded snacks enriched with shrimp processing by-product

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**Abstract**
The shrimp processing industries generate millions of tonnes of by-product annually, which result in a loss of edible portion and presents a considerable waste disposal problem. An attempt was made to develop nutrient rich extruded product from underutilized shrimp shell powder (*Litopenaeus vannamei*) with mixture of cereal flours using twin screw extruder. Ready to eat snack was developed using shrimp shell powder (5%, 10%, and 15%) mixed with mixture of rice, corn and sorghum and prepared spice mixture. Extrusion cooking formulation consisting of shrimp shell powder and cereals mixture were extruded at moisture content 7 per cent, screw speed 350 rpm, sectional barrel temperature of 60º C and 120ºC and 2 mm diameter of die. Extruded product was fried in edible oil with prepared spice mixture. The resulting extruded was analysed nutritional and organoleptic characteristics. Highest Protein content was found in SSP 15% enriched extruded snack (13.07±0.27%) and was lowest in control extruded snack (8.73±0.07%). However, addition of more than 5% of shrimp shell powder reduced the acceptability and hence the optimum percentage of shrimp shell powder that can be added to extruded snack product is 5%.

**Keywords:** Shrimp shell powder, extruded product, nutritional value, organoleptic characteristics, cereal flour

## Introduction
The shrimp processing industries mainly based on species like *Litopenaeus vannamei* (white leg shrimp), *Penaeus monodon* (Giant tiger shrimp), *Penaeus semisulcatus* (Green tiger shrimp), *Metapenaeus dobsoni* (kadal shrimp), *Metapenaeus affinis* (Ginga shrimp). Shrimp processing industries generate large amount of shrimp waste which is around 45-55% weight of raw shrimp [9]. On a global basis, the shrimp processing industry produces over 7,00,000 million tons of shell wastes and Sea food processing industry in India generates 8.5 million tons of shell waste per year [19]. Shrimp waste (dry weight basis) contains protein (35–50%), chitin (15–25%), minerals (10–15%) and carotenoids [17]. [11] has studied that the unutilized shrimp shell waste with high quality protein can be further fortified into crackers. Snacks have become an important part of the eating habits of the majority of the world's population as they provide momentary comfort and satiety. The most commonly consumed snacks are made mainly of corn and wheat, and they have few or no food properties that affect health due to their added sugars, fat, salt and dressings [15]. Extruded snack foods have become an integral part of the eating habits of most of the world's population. Consumer acceptance of extruded foods is mainly due to the convenience, value, attractive appearance, and texture found to be particular for these foods, especially when it concerns to snack products [7]. However, studies on the incorporation of shrimp shell powder as raw material for extruded snack preparation are not available much. Utilization of shrimp waste for development of value-added products will help in maintaining the economic viability of industry as well as reduce the environmental pollution [19]. Based on the above evidences, the aim of the present study is incorporating shrimp shell powder in the preparation of extruded snack to increase their nutritional value.

## Materials and Methods
*Litopenaeus vannamei* head and shell waste was brought from nearby shrimp processing plant and was iced immediately in the ratio of 1:1 and transported to the Laboratory in chilled condition. The shrimp shell waste (SSW) was washed thoroughly with chilled potable water

and used for the preparation of shrimp shell powder. The Shrimp shell wastes (SSW) was boiled in hot water for 10 -15 minutes. Then the shrimp shell waste was dried in mechanical drier at 60°C for 2 hours and then drying was continued for another 20 hours at 40°C. Dried shrimps shell waste was pulverized /sieved and fine milled, packed in HDPE pouches and stored at room temperature

The shrimp shell powders were used for the development of the product. Other ingredients such as Corn flour, Rice flour, sorghum flour and spice mixture prepared from cumin powder, ginger powder, garlic powder, tomato powder, onion powder, chilli powder, black paper powder, coriander powder, citric acid, salt (2: 2.5: 2.5: 2: 2: 2.5: 1:1: 0.5: 4) were used for the experiment. A weighed amount of shrimp shell powder was mixed with a known quantity of corn, rice and sorghum flour and 7% water was added. These ingredients were hand mixed and left for equilibration for minimum of one hour. The twin screw extruder was kept on for 30 min to stabilize the set temperature and ingredients were transferred to feed hopper and the feed rate was adjusted to 15kg/h for easy and non-chocking operation. The above mixture was passed through the twin screw extruder. Then product was collected at the die end. Prepared extruded products were subjected to deep frying for 2-3 minutes. Fried Products were allowed to drained and cooled at ambient temperature. Spice mixture was added to enhance taste of final extruded product. The operation conditions of the equipment are given in Table 1.

**Table 1:** The operation conditions of the equipment

| Sl. No. | Parameter | | value |
|---|---|---|---|
| 1. | Die diameter | | 3 mm |
| 2. | Barrel screw speed | | 350 rpm |
| 3. | Barrel temperature | Heater 1 | 120° c |
| | | Heater 2 | 60° c |
| 4. | Feeding rate | | 21 rpm |
| 5. | Cutter speed | | 420 rpm |
| 6. | Line voltage | | 450 voltage |

Moisture content of extruded snacks were determined by [1]. Moisture content corresponds to the weight loss of the sample. The crude protein content was determined by estimating total nitrogen by [1]. Crude protein content was calculated by multiplying total nitrogen content by 6.25 and expressed as percentage weight of sample. The crude fat content was determined by [5]. Ash and fibre content were determined by [1]. Total carbohydrates in the samples were estimated by hydrolysis method as described in [2]

## Results and Discussion

### (i) Proximate analysis

The proximate composition of shrimp shell powder (SSP) in the optimized extruded snack product is shown in Table 2. Increasing percentage of the shrimp shell powder in the extruded snack product were shown increasing levels of moisture, protein, ash, fibre content in the extruded shrimp shell powder snack and resulted in decrease of carbohydrates content but there was no significant change in the fat content.

**Table 2:** The proximate composition of shrimp shell powder (SSP) optimized extruded snack

| Sample | Moisture (%) | Protein (%) | Fat (%) | Ash (%) | Fiber (%) | CHO (%) |
|---|---|---|---|---|---|---|
| Control | 4.60±0.16 | 8.73±0.07 | 24.04±0.10 | 1.38±0.05 | 3.64±0.16 | 57.61±0.57 |
| SSP 5% | 5.43±0.08 | 9.45±0.20 | 24.68±0.08 | 2.61±0.21 | 3.74±0.16 | 54.05±0.12 |
| SSP 10% | 6.08±0.10 | 10.2±0.24 | 25.65±0.22 | 3.29±0.26 | 3.84±0.23 | 50.94±0.22 |
| SSP 15% | 6.31±0.16 | 13.07±0.27 | 24.12±0.21 | 4.58±0.21 | 3.98±0.43 | 47.94±1.03 |

Highest moisture content was found in SSP 15% enriched extruded snack (6.31±0.16%) followed by the SSP10% (6.08±0.10%) and SSP5% (5.43±0.08%) and lowest in control snack (4.6±0.16%). Similar trend was observed by [13] where the moisture content of the control sample was 4.12%, and those of 1%, 2%,3% chitosan fortified samples were found to be 4.23, 5.28 and 5.40 % respectively. [16] Also reported increase in moisture content of the red fish meat-based fried snacks with an increase in the content of red fish meat.

Highest Protein content was found in SSP 15% enriched extruded snack (13.07±0.27%) and lowest in control snack (8.73±0.07%). According to [4] addition of powdered shrimp significantly increased the protein content of the snacks and16% powdered shrimp have more protein content of 19.51% compared to 2%, 4%, 8% of powdered shrimp. Highest fat content was found in SSP 10% enriched extruded snack (25.65±0.22%) followed by the SSP 5% (24.68±0.08%) and SSP 15% (24.12±0.21 %) and lowest in control snack (24.04±0.10%). Similar finding was observed by [18] where fat content recorded was 30.6 to 31.7 per cent after frying the product. Variation noted in present study is due to differential composition of shrimp shell powder used in feed mix as well as time and method of frying. The ash content of the control sample was 1.38±0.14 % whereas those of 5%, 10%, and 15% SSP fortified samples were 2.61±0.21%, 3.29±0.26 % and 4.58±0.21% respectively. Ash content in the extruded snack increased with increased shrimp shell powder and this may be due to the higher mineral content in shrimp shell powder (SSP). The extruded product made from incorporating fish powder were also shown similar ash content (1.38 ± 0.02 to 5.14 ± 0.10) as described by [3].

Highest fibre content was found in SSP 15% enriched extruded snack (3.98±0.43%) and was lowest in control snack (3.64±0. 16%). Similar trend was observed by [20] that is with increasing the level of soy meal flour from 0 to 20%, the fibre contents of the extrudates increased from 0.84 to 1.57%. The carbohydrates content decreased from 57.61±0.57% in control extruded snack to 47.94±1.03% in15% shrimp shell powder enriched snack. These results are in agreement with the reports of [10] who added tilapia flour when formulating snacks since an increase in protein content results in a proportional reduction in carbohydrates. [14] also found similar observation where the carbohydrate content ranged from 61 to 72 % in product made from fish powder, rice and corn at ratio of 20:40:40.

**(ii) Sensorial analysis**

**Table 3:** Sensory characteristic profiles of extruded snacks

| Sample | Appearance & Color | Crispiness | Odor | Taste | Texture | Overall acceptability |
|---|---|---|---|---|---|---|
| Control | 9.00±0.18 | 8.81±0.28 | 8.22±0.23 | 8.84±0.09 | 8.52±0.05 | 8.52±0.35 |
| SSP 5% | 8.64±0.38 | 8.82±0.23 | 8.41±0.07 | 8.92±0.04 | 8.61±0.07 | 8.74±0.17 |
| SSP 10% | 8.13±0.54 | 8.33±0.27 | 8.54±0.10 | 7.97±0.04 | 8.13±0.08 | 7.89±0.33 |
| SSP 15% | 6.85±0.10 | 6.94±0.60 | 6.92±0.29 | 7.24±0.02 | 7.52±0.01 | 7.32±0.10 |

The panel of semi-trained people consisting of ten members were given the extruded snack food samples for evaluation of organoleptic characteristics *viz*. appearance and colour, flavour, taste, texture, and overall acceptability. Sensory characteristic profiles of extruded snacks are given in Table 3. All sensory characteristics such as general appearance, surface texture, flavor, crispiness and overall acceptability were obtained more score in 5% SSP (8.74±0.17) enriched extruded snack compared with control (8.52±0.35) and 10%,15% SSP (7.89±0.33, 7.32±0.10) enriched extruded snack. 15% SSP enriched extruded snack extruded product was strongly disliked by panelist due to strong shrimp odor. Protein enrichment was found to reduce expansion, and to increase hardness, of the extrudates as reported by [21]. This might have been the reason for the declining acceptability of the products with increase in concentration of protein rich shrimp shell powder. Sensory characteristics were influenced by extruded raw materials, concentration of fish flour, starch content, feed moisture content (Kumar *et al.*, 2010) [12]. [6] reported that the addition of more than 10% of blanched dried fish powder reduced the overall acceptability of the extruded snack. [11] reported that the sensory and biochemical characteristics with 5% SSP found suitable for the shrimp croquette preparation. [8] reported the overall acceptability of 3% SSP suitable for preparation of lindur fruit potato simulation chips.

Present study with 5% shrimp shell powder in food mix at given instrument parameters can produce nutrient rich extruded snack with good overall acceptability from underutilized crustacean resources with better returns of value.

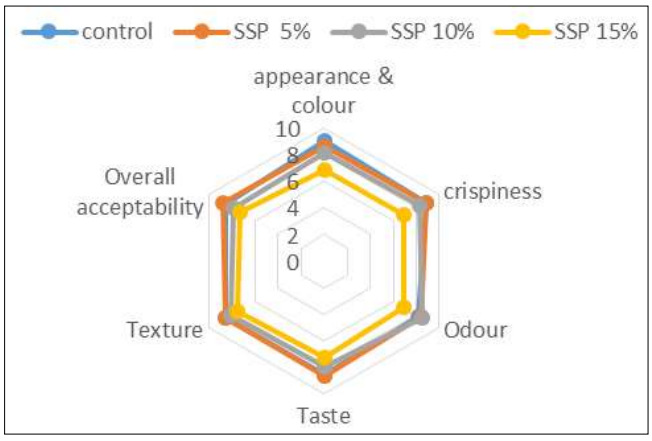


**Fig 1:** Sensory characteristic profiles of extruded snacks

## Conclusion

Consumer preferences have been changing in recent years, adopting to new consumer habits and life models. The market shares of ready-to-eat food snack food and breakfast cereals are growing almost everywhere in the world but that snack food have less nutritional value. So, Incorporation of shrimp shell powder increases the protein content of the extruded snack product and decreases the carbohydrate content. However, addition of more than 5% of shrimp shell powder reduced the overall acceptability of the extruded snack. Present study with 5% shrimp shell powder in food mix at given instrument parameters can produce nutrient rich extruded snack with good overall acceptability from underutilized crustacean resources with better returns of value.

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