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Innovative Seafood Health Mix Powder from Juveniles of *Leiognathus* sp. and Their Quality for Human Consumption

K. Saritha and Jamila Patterson

Suganthi Devadason Marine Research Institute, Tuticorin Tamil Nadu, India

Abstract: A large proportion of juvenile fishes which are landed as bycatch and some species are used for fish meal and poultry feed preparation and some are discarded as waste. To overcome malnutrition, these wasted resources were used for the preparation of nutritional rich health mix powder and their quality, shelf life and consumer acceptance were assessed. This product is safe for human consumption up to six months.

Key words: Trash Fish · Value Added Products · Nutrients · Quality Parameters

INTRODUCTION

Commercial fishing effects of targeted sea foods also incidentally fish several other non targeted sea foods. This is referred as 'bycatch' or discards and is generally known as trash fishes. Trash fish generally include species of little commercial important so they are dumped into the sea or on the shore. These fish are generally lack of economic value for their size and community's food habits.

Low value bycatch containing juvenile bony fishes viz., silver bellies, anchovies, mullets, sardine etc., are converted to fishmeal [1]. During 2001-2002, 651 t of silver bellies were landed at Visakhapatnam [2]. Landings of silver bellies in India during 2002-2003 were 62,100 t and it was 2.35% of total marine landings [3]. Estimated marine fish landing of *Leiognathus* sp. in Tuticorin, India during 2010 - 2011 were 995,245 t and it was 43.68 % of total by catch landings [4] and this *Leiognathus* sp. landing is increased year to year.

Trash fishes are generally classified in the category of fish that are relatively contained high protein, vitamins and minerals [5]. The identification of trash fish is not always clear. Previously it was fish of low to no economic value but some such fishes are now being converted into value added products [6]. Trash fish is the waste that can be used as a potential resource and so far only limited trash fishes are being used for traditional products, such as salted fish, fish crackers, fish sauce and fish meal [7].

The need for diverting the low valued fish for human consumption and the necessity for diversification of fish and fishery products in to value added products need special emphasis. Food eating habit of the people is changing very fast particularly in recent times, one of the important food processing technologies is the processing of low cost fish species into value added food products.

World population is expected to increase from 6 to 8.5 billion in the next 25 years. Meat and fish production must double in the next 25 years to meet the projected demand. Food imports will not provide a complete solution to food security problems. Increasing in productivity is the only real option. So there is still scope for improving supplies of fish for human consumption [8]. Malnutrition is very common in the less developed areas of Asia and Africa. In many of these areas the level of animal protein intake is only 1/5th of that in the more developed areas. It is reported that, in India, about 79% of the population is suffering from malnutrition and protein deficiency. The fish is one of the important food sources to solve the problem [9].

Value addition is a buzzword in the fish processing industry because of the increased realization of foreign exchange and high unit value for such products [10]. The technology for ready to cook food products preparation is now rapidly advancing in India. Many ready to eat or ready to serve products such as pickle, soup powder, wafers, cutlet, fish balls, chutney powder and sauce and fish sausage are prepared from low value by catch with de boned fish [1, 11]. Usually the fish

Corresponding Author: Jamila Patterson, Suganthi Devadason Marine Research Institute, Tuticorin Tamil Nadu, India.

contain 5-8% bone. Fish bone is rich in calcium as dicalcium phosphate, which has an ideal calcium phosphorus ratio of 2:1 [12]. The bones are in general soft and also difficult to remove. Through drying, salting or fermentation, the bones may become softer and subsequent preparation during cooking may make them even softer, crunchy and edible [13].

The present work was taken up to develop a simple process to convert locally abundant low valued trash fish such as small bony fish (silver belly) to nutritionally rich edible seafood Health mix powder without deboning the fish, which can be used as a fortifying agent to improve the food value and taste of different food items.

Fig. 1: *Leiognathus equulus*

Fig. 2: *Leiognathus dussumieri*

Fig. 3: *Leiognathus* sp. as trash fishes

Fig. 4: Edible fish powder

MATERIALS AND METHODS

Sample Collection: The juveniles of *L. equulus* (Fig. 1) and *L. dussumieri* (Fig. 2) were collected from the trash fishes (Fig. 3) at fish landing center of Tuticorin and brought to the laboratory in an ice box. The collected fishes were assessed for their freshness with respect to the sensory changes over the general appearance, eyes and gills of each specimen using quality index method [14].

Processing of Samples: The fishes were washed in potable water for several times to remove the dirt and debris's on the surface. Gutting (removal of gut) was done by cutting open the bellies to avoid microbial contamination and head and fins were removed and washed properly in running tap water and minced in a mincer. About 0.5% acetic acid was added to the meat. It was heated for 30 minutes and then filtered and pressed. The pressed cake was heated at 70-80°C in a water bath with ethanol (1:2) for 1 hour to remove fat and moisture from the meat. The solvent was drained and the extraction was repeated twice and the fish powder was dried properly following the method of Chattopadhay *et al*. [15] and Velayuthum and Indirajasmine, [16].

Preparation of Seafood Health Mix Powder: The ingredients (Table 1) were sundried, roasted, powdered and the powdered ingredients were well mixed with sea food powder. The mixed powder was named as sea food health mix powder (Fig. 4) and was packed in 100 g in the readily available 200 gauge low-density polyethylene (LDPE) sachets and stored at room temperature. The powders were analyzed at monthly intervals for six months. The stored health mix powder was used for the preparation of seafood health mix milk, seafood heath mix curd, seafood health mix sweet balls and seafood health mix mirche balls.

Table 1: Quantity of ingredients used for the preparation of Seafood health mix powder

Ingredients	Quantity (g)
Seafood powder	150g
Millet	10g
Green- gram	10g
Maize	10g
Rice	10g
Red rice	5g
Barley	5g
Moong dhal	10g
Pea	5g
Ragi	5g
Cardamom	5 No.
Wheat	5g
Horse-gram	10g

Proximate Composition and Mineral Contents: The proximate composition such as moisture content, protein, lipid and ash were determined according to the standard methods. Moisture content was determined by drying the sample in a hot air oven (Gallenkamp, HOTBOX; method OVB-306) at 105°C for 24 hours until contact weight [17]. The protein content was estimated by the method of Lowry *et al.* [18]. Lipid and carbohydrate contents were estimated by standard methods [19, 20]. Total ash content was determined by combusting the samples in the furnace at 550°C until the white colour of samples. Mineral contents viz., Calcium, Iron, Sodium and Potassium concentrations were measured by using APHA [21] through Atomic Absorption Spectrophotometer (ELICO, SL 194 Model).

Biochemical and Microbial Quality Changes: FFA content (% of oleic acid) was measured by using titrimetric method [22] and changes in biogenic amine such as TMA-N; TVB-N (mg N/100g) was determined by the Conway micro diffusion method [23]. pH analysis was done by the method of Goulas and Kontaminas [24] using HANNA pH213 microprocessor pH meter. PV, expressed as meq of peroxide oxygen/kg of fat, was determining according to the Egan *et al.* [25] method. The Thiobarbituric acid (TBA) (mg malondialdehyde/ kg fish flesh) was determining according to the Ke *et al.* [22] method. The microbiological characteristics such as Total Plate Count (cfu/g) and Total Fungal Count (Cfu/g) were done by the APHA [26] method using Plate Count Agar and Potato Dextrose Agar respectively. Pathogenic bacteria like *Escherichia coli* (MPN value); *Salmonella* and *Vibrio* (25 g) were enumerated by following the method of USFDA [27].

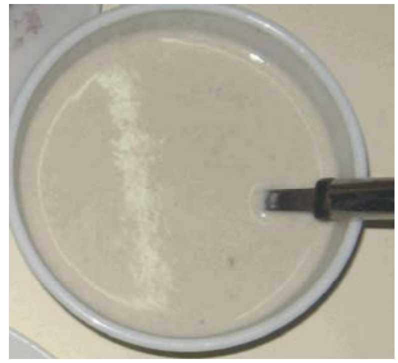

Fig. 4: Seafood health mix milk

Fig. 5: Seafood health mix curd

Fig. 6: Seafood health mix sweet balls

Fig. 7: Seafood health mix mirche balls

Organoleptic Analysis: The organoleptic quality of seafood health mix powder was assessed by adding 50% of the health mix fish powder at the time of cooking with the ingredients of common food items such as seafood health mix milk, seafood health mix curd, seafood health mix sweet balls and seafood health mix miche balls (Figs. 4 to 7). All the value added products were served to a taste panel of 6 to 8 members and appearance, colour, odour, taste texture and overall acceptability was determined by using hedonic scale of 1 to 9 [28] and the dishes were rated as 9 for excellent 6 for good and below 4 for poor or unacceptable.

RESULTS AND DISCUSSION

Value added products provide the opportunity to produce a new variety of innovative snack products. Third generation people, like snacks than the old generation people. Consumer demand is increased for ready to serve convenience products with minimal processing before consumption [29]. Nutritional constitution and quality of raw and health mix powder prepared from whole fish of *Leiognathus* species is presented in Table 1. The seafood health mix powder was rich in protein when compare to the raw fish protein content and it may be due to the addition of protein rich green gram, Moong dhal, Ragi and Horse-gram. Our results coincide with the results of Saritha and Patterson, [30] who reported increased level of protein in seafood cracker of *Penaeus japonicas* due to the terrestrial ingredient of sago. As well as seafood health mix powder was rich in minerals viz., calcium, phosphorus, potassium, sodium and iron. Mineral components such as sodium, potassium, magnesium, calcium, iron, phosphorus and sulphur are important for human nutrition [31]. The calcium and phosphorus content of the muscle portion of silver belly was reported to be 720.1 mg/100g and 735.3 mg/100g respectively [32]. Our study revealed of seafood health mix powder had calcium, phosphorus, potassium, sodium and iron contents due to use of whole fish and other ingredients for the preparation of health mix and similar results were reported by Chattopadhay *et al*. [15]. The proximate and mineral composition were significantly ($p<0.05$) increased in seafood health mix powder (Table 2) than the raw meat powder and during the storage period slight decreases ($p<0.05$) were noticed.

Moisture content is a precise pointer of the susceptibility of a product to undergo the microbial spoilage. Moisture also affects the stability and shelf life of the food product. Moisture content of the seafood health mix powder (Table 2) was low (3.65±0.25%) and varied ($p<0.05$) between 3.65±0.25 and 6.84±0.39% during storage (Table 3) but it's not exceed the acceptable level, which was essential to control the growth of microorganisms. Moisture content below 10% level was good for microbial safety of the fishery products [33]. It has a potential effect on the chemical reaction rate and microbial growth rate of the food product [34].

TMA-N, TVB-N are produced from degradation of proteins and non protein nitrogenous compounds mainly as a result of microbial activity [35]. TVB-N and TMA-N are increased ($p<0.05$) during storage period but the increase was within the acceptable limit of 30-35 mg N/100g, 10-15 mg N/100g for fishery products [36, 37]. There were no significant changes in FFA, PV and TBA (Table 3). The hydrogen Ion concentration of fishery products has been suggested as a good index of freshness and gives valuable information about the condition of fishery products [38, 39]. Anihouvi *et al*. [40] reported lower pH inhibits most of the bacterial activity. In our results revealed, during the storage period pH values were decreased in seafood health mix powder. Total plate count decreased throughout the storage period and direct correlation was observed between bacterial count and pH value of the product. Considerable increase in the bacterial counts resulted in decreased organoleptic quality [41] but in our result bacterial count did not increase and also sensory changes were admirable up to 6 months of storage.

Formation of FFA is a well established post mortem feature of products resulting from enzymatic hydrolysis of esterified lipids [42, 43]. FFA formation has been found to be inhibited by heating and it may be due to the hydrolysis of lipids by phospholipids [44]. Initial processing of the fish heating and drying process presumably inhibited enzymatic lipolysis. Rancidity developments due to primary lipid oxidation is a major problem in the storage of fishery products but in our study fat was already pressed out and so oxidative and hydrolytic rancidity were low in the seafood health mix powder during the storage period. TBA factor is responsible for the formation of secondary lipid oxidation rancid flavour, off odours, colour as well as texture deterioration and nutritional value [45]. In the health mix power the FFA, PV and TBA values were within the acceptable limit of 0.5-1.5% [46], 10-20 meq/kg of fat [37] and 8 mg malonaldehyde kg^{-1} [47] respectively at end of the storage period. Our result indicates that the seafood health mix powders are considered to be in good quality.

Table 2: Nutritional composition, biochemical and microbial quality of *Leiognathus* sp. raw meat and seafood health mix powder

Nutritional composition, biochemical and microbial quality parameters	Raw (*Leiognathus* sp.) meat powder	Seafood (*Leiognathus* sp.) health mix powder
Moisture (%)	3.85 ± 0.38	3.65 ± 0.25*
Protein (%)	24.30 ± 0.22	48.02 ± 0.31*
Lipid (%)	3.11 ± 1.26	0.82 ± 0.04*
Total ash (%)	4.26 ± 0.75	11.28 ± 0.09*
Carbohydrate (%)	7.3 ± 0.18	15.38 ± 0.31*
Calcium (mg/100g)	1210.36 ± 0.15	1341.21 ± 0.42*
Phosphorus	2256.09 ± 0.93	2893.11 ± 0.09*
Potassium (mg/100g)	53.02 ± 0.38	110.20 ± 0.22*
Iron (mg/100g)	35.81 ± 0.17	108.06 ± 0.13*
Sodium (mg/100g)	53.3 ± 0.09	104.23 ± 1.02*
TMA-N mg/100g	0.74 ± 1.03	0.42 ± 0.37*
TVB-N mg/100g	0.93 ± 0.02	0.62 ± 0.52*
FFA (% of oleic acid)	0.32 ± 0.3	0.2 ± 0.33*
Peroxide value(meqo2/kg fat)	1.0 ± 0.29	0.9 ± 0.05*
TBA(malondialdehyde mg/100g)	ND	ND
pH	7.0 ± 0.31	7.1 ± 0.39*
TPC (cfu/g)	2.3×10^3	2.1×10^2
TFC (cfu/g)	-	-
E. coli (MPN/G)	5	<2
Salmonella sp. (25g)	Absent	Absent
Vibrio sp. (25g)	Absent	Absent

ND – Not detected

Results are expressed as means ± standard deviation of triplicates.

.- (P < 0.05) is significant at 5% level

Table 3: Nutritional composition, biochemical and microbial quality of seafood (*Leiognathus* sp.) health mix powder during storage period.

Biochemical and microbial quality parameters	Initial	1st month	2nd month	3rd month	4th month	5th month	6th month
Moisture (%)	3.65 ± 0.25	4.12 ± 0.2	4.76 ± 0.62	5.03 ± 0.19	5.68 ± 0.33	6.22 ± 1.04	6.84 ± 0.39 *
Protein (%)	48.02 ± 0.31	47.83 ± 0.39	47.03 ± 31	46.55 ± 1.39	46.0 ± 0.93	45.91 ± 0.03	45.72 ± 0.28*
Lipid (%)	0.82 ± 0.04	0.74 ± 0.22	0.57 ± 0.41	0.42 ± 1.03	0.33 ± 0.19	0.30 ± 0.12	0.25 ± 0.35*
Calcium (mg/100g)	1341.21 ± 0.42	1341.1 ± 0.47	1340.93 ± 0.13	1340.84 ± 0.88	1340.8 ± 0.24	1340.8 ± 1.01	1340.75 ± 0.28*
Phosphorus (mg/100g)	2893.11 ± 0.09	2893.1 ± 0.37	2893.1 ± 0.46	2893.1 ± 0.33	2893.08 ± 0.42	2893.07 ± 0.05	2893.07 ± 0.23*
Potassium (mg/100g)	110.20 ± 0.22	110.2 ± 0.09	110.19 ± 0.09	110.19 ± 0.25	110.18 ± 0.31	110.18 ± 0.13	110.18 ± 0.39*
Iron (mg/100g)	108.06 ± 0.13	108.06 ± 0.91	108.06 ± 0.38	108.06 ± 0.81	108.05 ± 0.04	108.05 ± 0.38	108.05 ± 0.41*
Sodium (mg/100g)	104.23 ± 1.02	104.23 ± 1.0	104.23 ± 0.92	104.2 ± 0.9	104.2 ± 0.57	104.2 ± 0.36	104.2 ± 0.71*
TMA-N mg/100g	0.42 ± 0.37	0.66 ± 0.35	0.83 ± 0.29	1.36 ± 0.72	2.54 ± 0.49	5.39 ± 0.38	8.21 ± 0.93*
TVB-N mg/100g	0.62 ± 0.52	2.41± 0.51	5.67 ± 0.63	9.10 ± 0.75	13.45 ± 0.6	19.23 ± 0.39	23.86 ± 0.07*
FFA (% of oleic acid)	0.2 ± 0.33	0.31 ± 0.27	0.53 ± 0.68	0.65 ± 0.21	0.9 ± 0.03	1.1 ± 0.07	1.32 ± 0.83*
Peroxide value(meqo2/kg fat)	0.9 ± 0.05	2.8 ± 1.23	3.2 ± 0.38	3.9 ± 0.55	3.3 ± 0.26	4.0 ± 1.03	4.2 ± 0.26*
TBA(malondialdehyde mg/100g)	ND	ND	ND	ND	ND	1 ± 0.02	1.7 ± 0.72*
pH	7.1 ± 0.39	7.0 ± 1.17	7.0 ± 0.07	7.0 ± 0.55	6.93 ± 0.47	6.9 ± 0.25	6.89 ± 0.31*
TPC (cfu/g)	2.1×10^2	2.0×10^2	1.8×10^2	1.4×10^2	1.1×10^2	1.0×10^2	1.0×10^2
TFC (cfu/g)	-	-	-	-	-	-	-
E. coli (MPN/G)	<2	< 2	< 2	< 2	< 2	< 2	< 2
Salmonella sp. (25g)	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Vibrio sp. (25g)	Absent	Absent	Absent	Absent	Absent	Absent	Absent

ND – Not detected

Results are expressed as means ± standard deviation of triplicates

.- (P < 0.05) is significant at 5% level

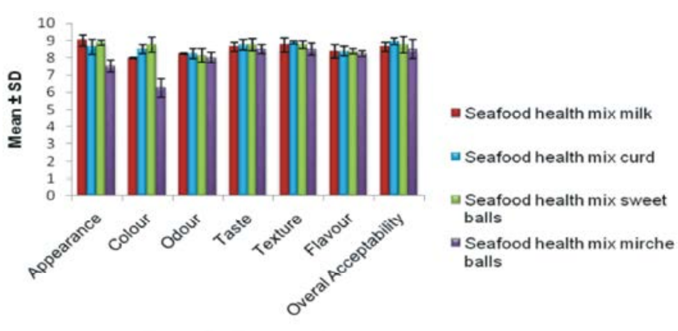

Fig. 8: Organoleptic analyses of seafood health mix powder products

Scoring was >8 - Excellent, 7- Good, 6- Acceptable, <4 - Reject

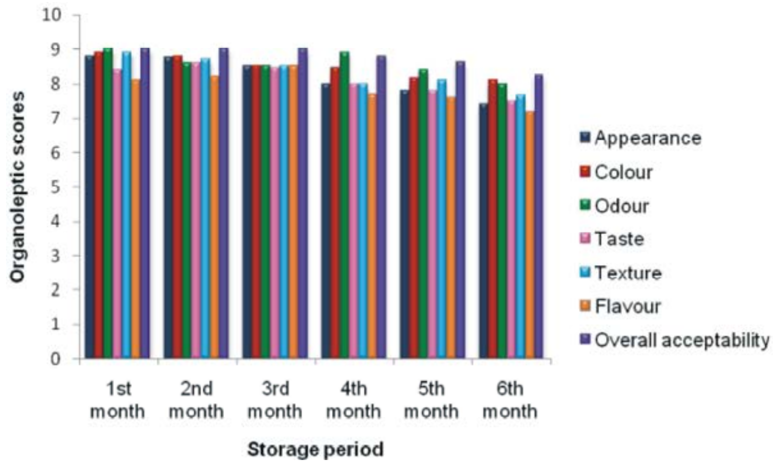

Fig. 9: Organoleptic analyses of seafood health mix powder products at storage period.
Each value represents the mean of 4 samples.
Scoring was >8 - Excellent, 7- Good, 6- Acceptable, <4 - Reject.

Total plate count of seafood health mix powder varied from 2.1×10^2 to 1.0×10^2 during the storage. If 10^6 microorganisms/g are considered as the TPC limit of acceptability [48]. Our fresh fish and edible powder (Table 2 ans 3) had bacterial count within the limit of acceptability throughout the storage period. Seafood health mix powder did not contain *E. coli, Salmonella, Vibro* and fungal count was not detected throughout the storage period because the samples were steam cooked before drying and pulverization. A similar result was reported by White [49]. Dry foods owe to their durability of storage but get rapidly attack by moulds and bacteria when exposed to moist air with subsequent absorption of water and hence good packaging is essential to retain the original quality [29]. High density polyethylene sachets are a good packaging material for food product proposed by Chattopadhyay *et al*. [15]. In contrast our results shows low-density polyethylene (LDPE) sachets showed good results during the storage period. An LDPE pouch which was readily available as a packaging material preserved the quality of seafood health mix powder without any adverse effect even up to 6 months.

Sensory scores of the health mix powder products at initial and storage period at ambient temperature were presented in Figs. 8 and 9. The product had better texture, odour, taste, appearance and improved storage characteristic. In the present study seafood health mix powder was incorporated as a supplement to four food formulations for humans, all the products are having excellent characters and all are accepted favorably by the consumers.

CONCLUSION

Seafood health mix powder was developed from the juveniles of *L. equulus* and *L. ldussumieri*. The seafood health mix powder was rich in protein and minerals and can be used as a fortifying agent for human consumption to mitigate malnutrition problem. However there exists a need to explore the possibility of developing wider range of products from trash fishes for the better utilization of these nutritious resources.

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