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RESEARCH ARTICLE

Monthly variation in Total lipid content (TLC) and Total soluble protein content (TSPC) of the fish processing waste generated from snakehead murrel, *Channa striatus* and catfish, *Wallago attu*

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Abstract

The present investigation has been carried out with the primary objective of estimating the lipid and protein content of processing waste produced from snakehead murrel (*Channa striatus*) and catfish (*Wallago attu*). The minimum total lipid content (2.63+0.23 g/100 g) was observed in the waste of *C. striatus* during May and the maximum total lipid content (11.20+0.24 g/100 g) was observed in the waste of *W. attu* during the month of February. The lipid content in processing waste of both the fish initially increased significantly ($p<0.05$) from December to February and thereafter decreased significantly ($p<0.05$) till May. On the other hand, the total soluble protein content of the processing waste of both murrel and catfish was minimum during the preparatory phase of spawning (December and January) and reaches its maximum value in pre-spawning phase (March to May). The total soluble protein content (52.30+1.30 mg/g) was observed to be minimum in the processing waste of *C. striatus* during the month of December and maximum (103.0+2.63 mg/g) in the waste of *W. attu* during the month of May. Thus, it can be inferred that the fish processing waste is a rich source of soluble protein and total lipids and therefore, should be properly utilized, leading to less wastage and extra revenue generation.

Introduction:-

Fish and other aquatic livestock have increasingly been exploited for human consumption. Of the fish that is processed for human consumption, 30-40% is wasted. Currently, these wastes are not fully utilized; they are sold off at low price, converted into value-added products (protein hydrolysate, amino acids, collagen, gelatin, oil etc.) or left to decompose leading to environmental pollution and wastage of bio resource (Mbatia 2011). In a decade, the world fish production has increased to 158.0 million tonnes in 2012 from 133.0 million tonnes in 2002, with Asia contributing about 68% (FAO 2014). India's contribution in the total world production was approximately 5.5% in 2012. Fish processing waste has a huge unexploited potential for value addition and find its use in functional foods and biochemical products for human consumption and for preparing animal feeds (Galardy *et al* 1984). Fish filleting leads to waste which can amount to 50% of the total weight of raw material. The waste is used in the production of fish meal and in very few cases, it is collected for the production of animal feeds; more frequently it is simply discarded. This solid waste has approximately the same protein content as fish flesh and these proteins of high nutritive value for human consumption may be recovered using different approaches. Fish wastes (solid waste and wastewater) are an important source of proteins, lipids and minerals with high biological value (Toppe *et al* 2007, Kacem *et al* 2011). Bioactive peptides isolated from various fish protein hydrolysates have shown numerous bioactivities such as antihypertensive, antithrombotic, immunomodulatory and antioxidative activities (Kim and Mendis 2006). Besides, fish processing waste is rich in minerals and enzymes that have alternative food, pharmaceutical, agricultural and industrial applications (Archer and Watson 2002). Fish waste is also a source of many useful natural polymers, fuels and other industrially important chemicals (Imaam *et al* 2008). Advanced industrial biotechnology process is applied for economic utilization of wastes in producing higher value-added products e.g., fish oil with higher level of polyunsaturated fatty acids (Chen *et al* 2006, Kim *et al* 2006, Zampolli *et al* 2006) has been extracted and integrated into food products and beverages (Rubio-Rodriguez *et al* 2010). Fish oil is one of the most important products of fishery industry. Fish liver oil, which is a rich source of fat, proteins, vitamin A and D has great medicinal values in curing or preventing diseases like xeropthalmia, impaired vision, eye defects, rickets and skin abnormalities (Kaur and Dhawan 1997). Vitamin A_2 is of particular importance since this form of vitamin A occurs only in freshwater fish liver oils, which is beneficial in vision as well as metabolic functions like growth (Roels 1967). Although, fish oil is being extracted from the livers of marine fishes such as cod and shark, its extraction from other visceral organs which contribute to the processing waste has not been explored much. Such information from fresh water fish is lacking. Thus, there is a great scope to investigate the lipid and protein content of the fish processing waste.

Materials and methods:-

a) Collection of sample of fish waste:-

Fresh samples of processing waste of *Channa striatus* (murrel) and *Wallago attu* (catfish) from the local fish markets were collected every month from December, 2014 to May, 2015. The samples were wrapped in labelled clean air-tight polythene bags and embedded in abundant crushed ice in the icebox. The samples were transported to the laboratory within 30-45 minutes and stored in a deep freezer (VESTFROST model) at -15^{0}C until analyzed.
The collection of samples exhibited that almost 15-20 percent of fish body weight is waste which includes fins, intestine, liver, kidney, blood, scales, vertebral column and viscera (head and female gonad being an edible portion).

b) Estimation of total lipid content:-

The total lipid content (TLC) of the fish processing waste was estimated by Soxhlet lipid extraction/solvent extraction method (AACC 1976).
Calculations:

$$\text{Total lipids (\%)} = \frac{W_2 - W_1}{a} \times 100$$

Where, a = Weight of the composite sample (fish waste) taken

W_1 = Weight of the empty crucible

W_2 = Weight of crucible with extracted lipids

c) Estimation of protein content:-

Total soluble protein content (TSPC) of the fish processing waste was estimated by the method of Lowry *et al* (1951).
Calculations:

$$\text{Total soluble protein} = \frac{\text{Conc. of standard}}{\text{O.D. of standard}} \times \frac{\text{O.D. of sample}}{\text{Vol of sample taken}} \times \frac{\text{Total volume}}{\text{Weight of sample taken}}$$

Where, Conc. = Concentration

O.D. = Optical density

Statistical analysis:-

One-way and multifactor analysis of variance (ANOVA) was used to determine the monthly variation and interspecific differences in the total lipids and soluble proteins of the fish waste. Significant differences between means were determined using Duncan's Multiple Range Test (MRT) as the post hoc analysis.

Results and discussion:-

a) Total lipid content of fish waste:-

The results obtained on the total lipid content (TLC) of processing waste of *C. striatus* and *W. attu*, analyzed during six months *viz.* December (2014) to May (2015) have been depicted in Table 1. A perusal of the results shows that there are considerable variations in total lipid content (TLC) with respect to the different months. The minimum TLC (2.63+0.23 g/100 g) was observed in the processing waste of *C. striatus* during May and the maximum TLC (11.20+0.24 g/100 g) was observed in the processing waste of *W. attu* during the month of February. The TLC of *C.*

striatus was statistically significant ($p<0.05$) from *W. attu* throughout the period of study. The TLC of the waste of both *C. striatus* and *W. attu* was significantly higher ($p<0.05$) in February than December and significantly lower ($p<0.05$) in April and May.

The results are substantiated by Paul *et al* (2013) who reported 2.86+1.4% of lipid content in fillets of *C. striatus*. Similarly, Tan and Azhar (2014) too, reported 2.89+0.14% of lipid content in whole fillet powder of *C. striatus*. Likewise, Dutta and Dutta (2014) observed similar monthly and seasonal variation in the muscle tissue of *W. attu* growing wild in large ponds near Punduah, West Bengal, India.

The spawning period of *C. striatus* and *W. attu* extends from June to September (FAO 2014). In the present study, the minimum values of total lipid content in both murrel and catfish were recorded during the month of May and maximum values were noted during February. Therefore, the results suggest that TLC in fish waste started increasing during the preparatory phase of spawning period i.e. December and January and reach its peak in February and then slowly decreases to reach the minimum value during the pre-spawning phase (March to early May).

A homogeneous study carried out by Dutta and Dutta (2014) and Joseph *et al* (2011) on seasonal variation in lipid content of catfishes, *W. attu* and *Arius arius*, respectively and reported that during reproductive season, lipid stored in various organs and tissues should be mobilized to the gonads for the development of gonads.

These observations are in close agreement and support the trend of lipid variation observed in the present study. A similar study carried out by Kandemir and Polat (2007) in muscle and liver of rainbow trout (*Oncorhynchus mykiss*) determined that the variations of the levels of lipids in liver and other organs are the results of irregular seasonal variations which affect the fish diet. However, it may be noted that along with seasonal variation, habitat conditions also influence fat synthesis in the fish. In lotic habitat, more amount of lipid content was observed in liver during winter season but significantly lower during the monsoon but in lentic habitat, apparently low lipid content was observed during winter season (Deka *et al* 2012).

b) Total soluble protein content in fish waste:-

Values obtained on total soluble protein content (TSPC) of processing waste of *C. striatus* and *W. attu*, analyzed for six months (December, 2014 to May, 2015) have been shown in Table 2. During the present study, minimum TSPC (52.30+1.30 mg/g) was recorded in the waste of *C. striatus* during the month of December and the maximum TSPC (103.0+2.63 mg/g) was observed in the processing waste of *W. attu* during the month of May. The TSPC in waste of *W. attu* was statistically significant ($p<0.05$) as compared to the total soluble protein content obtained from the waste of *C. striatus* throughout the investigation.

The TSPC in the processing waste of *C. striatus* increased significantly ($p<0.05$) from December (52.30+1.30 mg/g) to May (88.20+1.05 mg/g). Likewise, TSPC in waste of *W. attu* initially increased non-significantly from December (75.20+2.77 mg/g) to February (81.80+0.81 mg/g) but gradually witnessed a significant increase ($p<0.05$) from February to May.

As mentioned earlier, the spawning period of *C. striatus* and *W. attu* extends from June to September (FAO 2014). It can be concluded from the present study that TSPC of the processing waste of both murrel and catfish was minimum during the preparatory phase of spawning (December and January) and reaches its maximum value in pre-spawning phase (March to early May). This may be due to less food availability during December. However, the increasing trend in protein content may be correlated with the availability of food which provides a stimulus to the liver to build up energy reserves for impending gonadal maturation. Similar observations have been reported by Nisa and Asadullah (2011) and Jan *et al* (2012) who observed similar variation of crude protein in *Rastrelliger kanagurta* and *Schizothorax esocinus*, respectively which was recorded to be highest in June and lowest in December. The low protein content in December has also been correlated with its probable utilization for metabolic energy during less food availability in winter.

The results of the study are also in accordance with the observations recorded by Joseph *et al* (2011) who reported highest value of soluble protein in *A. arius* during May (pre-monsoon) and lowest in September (post-monsoon), with slight increase during October and November. The authors attributed this trend of soluble protein to the pre-monsoon conditions like high salinity and elevated temperature which provided a conducive feeding environment for the fish.

Table1: Monthly variation in total lipid content (TLC; g per 100 g) of processing waste of *Channa striatus* and *Wallago attu*

Fish (Species)	Month, Year						Mean (of all months)
	December, 2014	January, 2015	February, 2015	March, 2015	April, 2015	May, 2015	
Channa striatus	4.47±0.26^{a1}	4.84±0.21^{a12}	5.38±0.15^{a2}	4.80±0.14^{a12}	3.73±0.20^{a3}	2.63±0.23^{a4}	4.30±0.22
Wallago attu	9.98±0.17^{b1}	10.63±0.28^{b12}	11.20±0.24^{b2}	10.18±0.21^{b1}	8.99±0.14^{b5}	7.38±0.25^{b6}	9.72±0.24
Total	**14.45±0.22**	**15.47±0.25**	**16.58±0.21**	**14.98±0.21**	**12.72±0.19**	**10.01±0.31**	**14.02±0.30**

Values are Mean±S.E of samples, in triplicate.
Values with at least one same numeric superscript in a row do not differ significantly (p>0.05) w.r.t. different months.
Values with same alphabetic superscript in a column do not differ significantly (p>0.05) w.r.t. different fish.

Table 2: Monthly variation in total soluble protein content (TSPC; mg per g) of processing waste of *Channa striatus* and *Wallago attu*

Fish (Species)	Month, Year						Mean (of all months)
	December, 2014	January, 2015	February, 2015	March, 2015	April, 2015	May, 2015	
Channa striatus	52.30±1.30^{a1} (5.23)	59.80±1.87^{a2} (5.98)	64.20±2.43^{a2} (6.42)	73.30±0.66^{a3} (7.33)	81.30±2.60^{a4} (8.13)	88.20±1.05^{a5} (8.82)	**69.85±1.52 (6.98)**
Wallago attu	75.20±2.77^{b1} (7.52)	79.30±2.49^{b1} (7.93)	81.80±0.81^{b12} (8.18)	89.30±2.68^{b23} (8.93)	97.20±2.82^{b34} (9.72)	103.00±2.63^{b4} (10.30)	**87.63±2.28 (8.76)**
Total	**127.50±4.28 (12.75)**	**139.10±4.09 (13.91)**	**146.00±3.60 (14.60)**	**162.60±4.10 (16.26)**	**178.50±4.05 (17.85)**	**191.20±4.39 (19.12)**	**157.48±3.7 (15.75)**

Values are Mean±S.E of samples, in triplicate. Values in parenthesis represent the percentage.
Values with at least one same numeric superscript in a row do not differ significantly (p>0.05) w.r.t. different months.
Values with same alphabetic superscript in a column do not differ significantly (p>0.05) w.r.t. different fish.

Conclusion:-

The fish processing waste (fins, intestine, liver, kidney, blood, scales, vertebral column and viscera, excluding head and female gonad) of murrel and catfish, studied presently, is a rich source of soluble proteins and total lipids. The rise in fish waste generation causes its disposal and environmental pollution problems. It is, therefore, suggested that initiatives for proper utilization of fish waste may be undertaken globally since it has found many applications into pharmaceutical products, animal feed, biodiesel/biogas, dietetic products, food packaging, fish sauce and soup, cosmetics, enzyme isolation, organic fertilizer, etc. leading to less wastage and extra revenue generation, both for the government as well as the fish vendors.

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