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A STUDY ON THE PROXIMATE COMPOSITION, QUALITY. HEAVY METAL SAFETY OF TILAPIA (*OREOCHROMIS NILOTICUS*) FLESH AND CONSUMERS' RESPONSE TO A NEW PRODUCT (FISH BALL) PREPARED BY TWO FORMULATIONS FROM THIS FISH FLESH

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ABSTRACT

This research is the final part of our research project (MoST Project No. 78 – BS, 2019-20, Ministry of Science and Technology, Govt. of the Peoples' Republic of Bangladesh). In this part we have used tilapia (*Oreochromis niloticus*) fish. In the present research the proximate composition (Protein, Lipid, Ash and Moisture), quality, heavy metal safety of *Oreochromis niloticus* was studied/estimated in a number of experiments. Consumers' response to "Fish Ball" prepared from *Oreochromis niloticus* by two formulations was also studied. *Oreochromis niloticus* used in this research possessed 15% protein, 1.96% Lipid, 1.9% ash, 73.45% Moisture. The raw fish were of excellent freshness (Grade A, SDP=1.54). Quality in terms of TVB-N and TMA-N was excellent. TVB-N value was 20.93 mg/100g fish and TMA-N value was 4.26 mg/100g fish. Heavy metal safety (concentration in flesh) was investigated by estimation of Cadmium (Cd), Chromium (Cr), Lead (PB), Copper (Cu) and Zink (Zn). Cd concentration was 0.13 ppm, Cr concentration was 6.76 ppm, Pb concentration was 2.52 ppm, Cu concentration was 6.22 ppm, Zn concentration 29.4 ppm. Heavy metal concentration of raw *Oreochromis niloticus* flesh was within the maximum allowable limit except Cr and Pb. Fish Ball was prepared by using boiled flesh of *Oreochromis niloticus* by two formulations. Dip fried products were prepared by using different frying time. Consumers' Preference to 'Fish Balls' was studied by Triangle Test and Hedonic Test. Such statistical tests usually express acceptability of new product to the consumers. Panel Members 'liked most' the products prepared by Formulation – II (Boiled Fish flesh 72.5% + Boiled Potato 20% + Flour 2.5% + Egg, Salt, Spices 5%; frying time 5 minutes)

KEYWORDS: Tilapia (*Oreochromis niloticus*), Composition, Quality, Heavy metal, Fish Ball, consumers' response.

INTRODUCTION

Bangladesh is a riverine country. Fish and fishery products are good source of animal protein in Bangladesh from time immemorial. But the recent trend in major cities of Bangladesh is the decreasing trend/pattern in fish consumption among the children and the juveniles/young. School and college students are seriously reluctant about fish consumption. Difficulty and less time in purchase and preparation (descaling, cutting, washing, etc.) before cooking is another cause of such decreasing pattern of fish consumption in major cities of Bangladesh. As a result children and young are deprived of delicious taste, nutrition from fish. Considering this fact, attempt was taken for product development which will be ready to eat (after microwave heating) or ready to cook in home. Fish Ball is an example of such product. For better acceptance of such products different formulations may be attempted. In

general these technologies are known as NPD (New Product Development). NPD are of two types: Value added Product; and Minced Fish Product (Coated Fish product), e.g. Fish Ball, Fish finger, Fish burger. Connell (1980) mentioned such products as heat processed fish which are boiled, fried or steamed but are not packed in hermetically sealed containers. Depending upon its intensity, heat processing will kill a varying proportion of bacteria and destroy most flesh enzymes. Suzuki (1981) has described some Japanese products prepared from surimi. Johnston (1989) stated that products that are shellfish analogues have found greatest acceptance in such that, in the USA in 1984, about 94% of all surimi-based products were analogues and in 1987 the proportion was still 90%.

Normally, the desired sensory quality of such Fish Products influence consumers' preference/acceptance. Sensory quality of such new fish products depends on the Functional Properties of Fish Muscle Protein. Functional properties of proteins are the function of their structure which can be described at four different levels. Knowledge of structure and its manipulation by enzymes can indicate the potential use of the protein. There are some commonly used terms for functional properties of protein e.g. solubility, emulsification, water/oil absorption and binding, foam formation, viscosity and gelation. Each property has its specific mode of action and utilized in the preparation of specific product. Functional properties may be defined as "the overall physico-chemical behavior of performance of protein in fish during processing, storage and consumption". They reflect complex interactions that are influenced by the protein composition, its structure and intermolecular associations with the other ingredients such as water, carbohydrate and lipid. These interactions are further influenced by the environment in which they take place, and the result is a series of characteristics that enhance the quality and organoleptic properties of the product. Practically these properties are seen as: Good Texture and mouth feel; Lack of drip or shrinkage due to loss of fat and water; and Binding of particulate product.

Such NPD (New Product Development) is possible from indigenous fishes of Bangladesh. Due to heavy production of fish by the fish farming many freshwater fishes are now available with reasonable price. Such fish may be used for NPD. Once the quality and safety of such indigenous freshwater fishes are known then these fish species may be used for NPD. In the present research Tilapia (*Oreochromis niloticus*) was used as experimental/trial for this purpose.

Objective of this research was the preparation of Fish Ball with different formulations from the indigenous fishes of Bangladesh; Study of quality and safety of raw fish; Study of consumers' preference to the products (Fish ball).

These objectives have relationship to the present state of knowledge in the field. It has already been mentioned that the consumers' preference of such fish products depends on the sensory quality of the products which is related to the functional properties of fish muscle protein. Functional properties has different characteristics which are expressed by different terms and they have specific nature and function in use. Moreover, several factors affect the performance of protein as functional agent. That means several factors influence the functional properties of protein. These include: the nature of the protein; methods of preparation (including enzymatic /acid/alkali hydrolysis); concentration; temperature; pH and ionic strength of solution.

Apart from the above influencing factors the functional properties of fish protein is species dependent. Some fishes are pelagic, some are demarsal, some are fatty fish, some are lean fish. Functional properties of protein is different among these groups of fish.

In Bangladesh present state of knowledge is inadequate. It has been observed from experience during preparation of Fish Ball that some species of fish is a good raw material for NPD with good texture and mouth feel, but muscle of some species of fish produce foam like texture (e.g. cake, meringues). In pelagic fish, oxidative rancidity is initiated by oxygen before processing and proceeds even in the absence of oxygen. Functional property is affected from pre-rigor to post-rigor and during freezing and frozen storage. Collection of boneless, non-minced flesh and trembling it with salt polyphosphate to extract the proteinous gluey material to coat the flesh surface has been attempted but product fall apart due to lipid material interrupting gel continuum; and become quickly rancid and unacceptable due to auto-oxidation. In Bangladesh we don't know which species is suitable for NPD and which will give best result. The present research will produce reliable data and information which will be a base for NPD in Bangladesh.

MATERIALS AND METHOD

Source of raw fish

Tilapia (*Oreochromis niloticus*) was purchased from the van of a retailer who supply fish in the Bangladesh Agricultural University campus at Mymensingh, Bangladesh. Fishes were in excellent condition during purchase. Fishes were kept in a polyethylene bag and transported to the laboratory of the Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh. On arrival to the laboratory the fishes were subjected to freshness test and biochemical analysis to estimate nutritional composition, quality and heavy metal concentration of the fishes. A part of the purchased fish was stored at deep freeze for further use.

Freshness test

At first the fishes were subjected to freshness test i.e. SDP estimation by organoleptic method according to Howgate et. al. (1992). In doing so the seven characters

were studied defect points were plotted and total defect points were divided by seven. Result is SDP. Fishes were graded for freshness on the basis of this SDP value. Freshness test was conducted in the Laboratory of the Department of Fisheries Technology.

Biochemical analysis

Then the nutritional composition i.e. protein, lipid, ash and moisture was estimated by the methods of A. O. A. C. (1980). Quality of the raw fishes was studied by the methods of A. M. C. (1979).

Estimation of heavy metal concentration

Heavy metal concentration e.g Cr, Cd, Pb, Cu, Zn was estimated according to the methods of Eboh et. al. (2006) and Clesceri et. al. (1989). Heavy metal analysis was conducted in the laboratory of the Department of Fisheries Technology (sample preparation) and in Department of Aquaculture (sample digestion). Heavy metal concentration was estimated in the laboratory of the Bangladesh Institute of Nuclear Agriculture (BINA) in the Bangladesh Agricultural University campus, Mymensingh, Bangladesh. The method is described below

Sample preparation: In case of fish only the muscle is taken by a sharp knife and finely homogenized by a grinder. Muscle is taken from the dorsal side of the fish. Accurately weighed 5g homogenized sample is taken in a crucible and dried at 105^0C for 24 hours in an electric oven. This dried sample is used for heavy metal analysis/estimation.

Sample digestion: Accurately weighed 0.5 – 1.0g oven dried sample is taken in a Microkjeldahl Flask. A volume of 10 ml Nitric Acid is added to this flask. After that 5 ml perchloric acid is added to this flask. The Microkjeldahl Flask containing the sample and acid mixture is placed in an Electrothermal heater and heated at 30^0C – 80^0C. Heating starts at 30℃ and gradually increased to 80^0C. During heating the colour of the liquid in flask (sample+acid) is turned into reddish colour, which is turned into white colour afterwards. Then the flask with the content is cooled. Then 6 ml 6N HCl is added to the flask. The Kjeldahl Flask with its content is placed in the Electrothermal heater and heated at 30^0C – 80^0C.Heating temperature gradually rises from 30^0C to 80^0C. This time the colour of the liquid (sample + acid) in flask is first yellow colour which is turned into white colour afterwards. Then the flask with its contents is cooled. The content of the flask is taken in a 50 ml volumetric flask. The volume is made 50 ml with distilled water. This solution is filtered by ashless Whatman No. 1 filter paper.

Analysis by Atomic Absorption Spectrophotometer: The digested and diluted sample is then subjected to analysis by Atomic Absorption Spectrophotometer. That means the absorbance of colour of solutions is measured by Atomic Absorption Spectrophotometer at a specific wave length. The wave length for such measurement is for As, Cr and Cd is 193.7 nm, 127 nm and 217 nm respectively. The absorbance and corresponding concentration of heavy metal is observed or determined from a standard graph which is previously prepared by standard compound of heavy metal. Calculation is done by the following formula:

$$\text{Heavy metal} = \frac{\text{Concentration observed (ppm)} \times \text{Final volume of sample (ml)}}{\text{Weight of sample in g}} \text{ (ppm)}$$

Consumers' preference test

Consumers' preference to the product e.g. Fish Ball will be conducted by Consumers' Preference Test (Triangle Test) according to the methods described by Smith (1989), and acceptance test was conducted by Hedonic Test according to the method of Watts et. al. (1989). Consumers' preference/acceptance test was conducted in the Department of Fisheries Technology.

Processing and preparation of New Product (Fish Ball)

Fish Ball: Fish Ball was prepared from boiled fish muscle. At first the fishes were filleted. Then muscle was taken out of the fillets by a sharp knife. The muscle was boiled in pure boiling water. Some ingredients were mixed with fish muscle. Among the ingredients egg, corn flour, boiled potato, salt, spices are main. Then this fish muscle is round shaped manually. Roundels (round shaped fish muscle) were dipped in a thick solution of egg. Then the roundels were deep fried for five minutes in hot edible oil and cooled to room temperature. This type of product is known as Fish Ball. Fish ball was prepared from Tilapia (*Oreochromis niloticus*) with different formulations. In preparing Fish ball different formulations were been followed to find out the best formulation preferred by the consumers. Formulation of the products are stated in the tables. Tilapia balls were prepared without breadcrumbs.

RESULT AND DISCUSSION

Raw fish; and Fish Ball prepared from *Oreochromis niloticus*

Result of Proximate composition analysis and quality of *Oreochromis niloticus* have been presented in the Table 2.1. Proximate composition of this species was found to be similar to other freshwater fish species. Protein was 15%, lipid 1.96%, ash 1.92% and moisture was 73.45%.

Quality of *Oreochromis niloticus* used in this research has been presented in the Table 2.2. The freshness SDP value (sensory quality) of *Oreochromis niloticus* was 1.54 (Grade A). Overall quality of *Oreochromis niloticus* used in this research was excellent, TVB-N value was

20.93 and TMAN value was 4.26. Heavy metal (Lead, Chromium, Copper, Cadmium, Zinc) concentration of *Oreochromis niloticus* fish muscle, used for fish ball preparation, has been presented in Table 2.3. Pb concentration was 2.52 ppm, Cr concentration was 6.76 ppm. Cu concentration was 6.22 ppm, Cd concentration was (0.33 ppm), Zn concentration was 29.47 ppm.

Composition of Fish Ball prepared by two formulations from *Oreochromis niloticus* has been presented in Table 2.4. In formulation I the composition of Fish Ball was boiled fish muscle 82.50%, boiled potato 10%, corn flour 2.5%, other ingredients 5% (egg, salt, spices). In formulation II the composition of Fish Ball was boiled fish muscle 72.50%, boiled potato 20%, corn flour 2.5%, other ingredients 5% (egg, salt, spices). In the formulations the ingredients have specific function. Flour (wheat flour or corn flour), during heating, denatures protein to prevent springiness in the batter, damage starch to increase water holding capacity. Potato was chosen according to crispiness or toughness or other kinesthetic property which may be required (sensory property). Egg acts as adhesive. Salt was used for taste and flavor and to reduce freezing point. Spices have function in flavor and taste of batter.

Result of Triangle Test has been presented in Table 2.5 and Table 2.6. A panel of 20 members took part in the Triangle Test. Conclusion of the Triangle Test was that there was no detectable difference between two formulations of Fish Ball. Result of Hedonic Test has been presented in Table 2.7. Same panel members took part in the hedonic test to express degree of liking or disliking to the products developed by two formulations from *Oreochromis niloticus*. A panel of 20 members expressed their opinion about degree of liking or disliking on a 9 point scale. Result of hedonic test was that the products were quite acceptable to them but Formulation II was better and more acceptable (the sample which contained 72.5% boiled fish muscle, 20% boiled potato, 2.5% corn flour, 5% other ingredients e.g. egg, salt, spices). Table 2.8 is for the Tabulated category scores for Hedonic Test and Table 2.9 is for ANOVA Table for Hedonic Test foe the Fish Ball prepared from *Oreochromis niloticus.*

Table 2.1: Proximate composition of. *Oreochromis niloticus.*

Parameters	***Oreochromis niloticus***	**MAL**
SDP	**1.54**	**2***
TVB-N (mg/100g)	**20.93**	**30**
TMA-N (mg/100g)	**4.26**	**8 -10**

*Grade A

Table 2.2: Freshness and quality of *Oreochromis niloticus.*

Parameters	***Oreochromis niloticus***
Protein (%)	**15.00**
Lipid (%)	**1.96**
Ash (%)	**1.92**
Moisture (%)	**73.45**

Table 2.3: Heavy metal content of *Oreochromis niloticus.*

Heavy Metal	***Oreochromis niloticus***	**MAL (ppm)**
Cadmium (Cd) ppm	**0.13**	**1.00**
Chromium (Cr) ppm	**6.76**	**0.05**
Lead (Pb) ppm	**2.52**	**2.00**
Copper (Cu) ppm	**6.22**	**10.00**
Zinc (Zn) ppm	**29.47**	**100.00**

Table 2.4: Composition of fish balls prepared by two formulations from *Oreochromis niloticus.*

	Ingredients	**Formulation I**	**Formulation II**
Oreochromis niloticus	Boiled fish muscle	82.50%	72.50%
	Boiled potato	10%	20%
	Corn flour + Wheat flour	2.50%	2.50%
	Egg, Salt, spices (turmeric powder, chili powder, ginger paste, garlic paste)	5.00%	5.00%
	Edible oil for frying	Dip frying	Dip frying
	Bread crumb	--	--

Consumers' response

Table 2.5: Panelists response to the products during Triangle test to determine whether or not there is a detectable difference between two formulations of fish balls prepared from *Oreochromis niloticus*.

Among the supplied samples which is odd sample*?

Panelist	Sample A	Sample B	Sample C
1	√		
2	√		
3	√		
4	√		
5	√		
6	√		
7			√
8		√	
9		√	
10		√	
11		√	
12	√		
13	√		
14	√		
15	√		
16	√		
17		√	
18	√		
19		√	
20			√

*Sample A was prepared by formulation I (odd sample) and Sample B and C were prepared by formulation II.

Table 2.6: Result of Triangle test to determine whether or not there is a detectable difference between two formulations of fish balls prepared from *Oreochromis niloticus*.

Parameter	Result
Panel size	20
Test statistic	12
Critical value	13
Significance level (%)	1
Decision	There is no detectable difference between two formulations of fish balls prepared from *Oreochromis niloticus*.

Photograph of the products prepared from *Oreochromis niloticus*

Fig. 1: New product (Fish balls) prepared from *Oreochromis niloticus* by two formulations.

Consumers' preference/acceptance test (degree of liking or disliking)

Table 2.7: Result of Hedonic test to express degree of liking or disliking to the products developed by two formulations from *Oreochromis niloticus*.

9 Point Scale	Formulation I Sample A	Fprmulation II Sample B and C*	
		Sample B	Sample C
Like Extremely	---	4 (20%)	7 (35%)
Like Very Much	7 (35%)	9 (45%)	8 (40%)
Like Moderately	9 (45%)	5 (25%)	4 (20%)
Like Slightly	1 (5%)	1 (5%)	1 (5%)
Neither Like Nor Dislike	1 (5%)	NIL	NIL
Dislike Slightly	NIL	NIL	NIL
Dislike Moderately	1 (5%)	NIL	NIL
Dislike Very Much	1 (5%)	NIL	NIL
Dislike Extremely	NIL	NIL	NIL

Panel Size = 20

*For hedonic test sample B and C were of same formulation but frying time of sample C was more than Sample B.

Hedonic Test

Table 2.8: Tabulated category scores for Hedonic Test for Fish Ball prepared from *Oreochromis niloticus.*

Panelist	Sample A		Sample B		Sample C		Panelist Total	Panelist Mean	(Each Panelist Total^2)
	x	x^2	x	x^2	x	x^2			
1	**6**	**36**	**8**	**64**	**9**	**81**	**23**	**7.66**	**529**
2	**7**	**49**	**8**	**64**	**9**	**81**	**24**	**8**	**576**
3	**7**	**49**	**8**	**64**	**9**	**81**	**24**	**8**	**576**
4	**7**	**49**	**8**	**64**	**9**	**81**	**24**	**8**	**576**
5	**8**	**64**	**8**	**64**	**8**	**64**	**24**	**8**	**576**
6	**7**	**49**	**8**	**64**	**7**	**49**	**22**	**7.33**	**484**
7	**8**	**64**	**8**	**64**	**9**	**81**	**25**	**8.33**	**625**
8	**8**	**64**	**7**	**49**	**8**	**64**	**23**	**7.66**	**529**
9	**8**	**64**	**7**	**49**	**8**	**64**	**23**	**7.66**	**529**
10	**7**	**49**	**7**	**49**	**7**	**49**	**21**	**7**	**441**
11	**8**	**64**	**7**	**49**	**7**	**49**	**22**	**7.33**	**484**
12	**7**	**49**	**9**	**81**	**8**	**64**	**24**	**8**	**576**
13	**7**	**49**	**9**	**81**	**8**	**64**	**24**	**8**	**576**
14	**5**	**25**	**7**	**49**	**8**	**64**	**20**	**6.66**	**400**
15	**2**	**4**	**5**	**25**	**6**	**36**	**13**	**4.33**	**169**
16	**3**	**9**	**6**	**36**	**7**	**49**	**16**	**5.33**	**256**
17	**8**	**64**	**9**	**81**	**8**	**64**	**25**	**8.33**	**625**
18	**7**	**49**	**8**	**64**	**9**	**81**	**24**	**8**	**576**
19	**8**	**64**	**9**	**81**	**8**	**64**	**25**	**8.33**	**625**
20	**7**	**49**	**8**	**64**	**9**	**81**	**24**	**8**	**576**
Treatment Total	**ΣxA = 135**	**ΣxA^2 = 963**	**ΣxB = 154**	**ΣxB^2= 1206**	**ΣxC= 161**	**ΣxC^2= 1311**	**Σxp = 450**	**7.49**	**Σxp^2 = 10304**
Grand Total	**135 + 154 + 161 = 450**								
Treatment Mean	**6.75**		**7.7**		**8.05**				

Highest Score = 9 = Like Extremely; Lowest Score = 1 = Dislike Extremely

CALCULATION

Correction Factor CF = (Grand Total^2) ÷ N = $(450)^2 \div 60$ = 3375.

Total Sum of Squares SS(T) = Σ (each individual response^2) – CF = 450^2 – 3375 = 3480 – 3375 = 105

Treatment Sum of Squares SS(Tr) = Σ{(each treatment total^2) ÷ number of responses per treatment} – CF = $\{(135^2+154^2+161^2) \div 20\}$ – 3375 = 18.1

Panelist Sum of Squares SS(P) = Σ{(each panelist total^2) ÷ number of responses per panelist} – CF = {10304÷3} – 3375 = 59.66

Error Sum of Squares = SS(E) = SS(T) – SS(Tr) – SS(P) = 105 – 18.1 – 59.66 = 27.24

Total degrees of freedom df(T) = Total number of responses – 1 = 60 – 1 = 59
Total degrees of freedom df (Tr) = The number of treatment – 1 = 3 – 1 = 2
Panelist degrees of freedom df (P) = The number of panelists – 1 = 20 – 1 = 19
Error degrees of freedom df (E) = df (T) – df (Tr) – df (P) = 59 – 2 – 19 = 38

Treatment Mean Square, MS (Tr) = SS(Tr) ÷ df (Tr) = 18.1 ÷ 2 = 9.05
Panelist Mean Squares, MS(P) = SS(P) ÷ df(P) = 59.66 ÷ 19 = 3.14
Error Mean Squares MS(E) = SS(E) ÷ df(E) = 27.24 ÷ 38 = 0.716

Table 2.9: ANOVA Table for Hedonic Test (Fish ball prepared from *Oreochromis niloticus*).

Source of Variation	df	SS	MS	F ratio Calculated	F ratio Tabular ($p \leq 0.05$)
Total (T)	59	105			
Treatment (Tr)	2	18.1	9.05	12.63	3.49
Panelist (P)	19	59.66	3.14	4.38	2.12□2.20
Error (E)	38	27.24	0.716		

Since the calculated treatment F ratio of 12.63 exceeded the tabular F ratio of 3.49, it may be concluded that there was a significant ($p \leq 0.05$) difference among the mean hedonic scores for the three fish ball samples prepared from *Oreochromis niloticus*.

The calculated panelist F ratio of 4.38 exceeded the tabular F ratio of 2.12□ 2.20. Thus there was significant panelist effect on the three fish ball samples prepared from *Oreochromis niloticus*.

Duncan's New Multiple Range Test
This test compares the differences between all pairs of means to calculated range values for each pair. If the difference between pairs of means is larger than the calculated range value, the means are significantly different at the specified level of significance. Range values are computed based on the number of means that lie between the two means being tested, when the means are arranged in order of size.

To carry out the Duncan's Test, treatment means were arranged in order of magnitude as shown below

Fish Ball sample	C	B	A
Treatment means	8.05	7.7	6.75

To compare the 3 means in this experiment, range values for a range of 3, 2 means were calculated from the following equation:

$$\text{Range} = Q\sqrt{\frac{MS(E)}{t}}$$

MS(E) taken from ANOVA Table was 0.716.
't' is the number of individual responses used to calculte each mean, here t = 20.

$$\text{Range} = Q\sqrt{\frac{0.716}{20}} = Q\,(0.189)$$

Q values were obtained from statistical table at the same level of significance used in ANOVA, ($p \leq 0.05$). The df (E) or 38 df are also needed to determine Q values. From statistical table Q values for 38 df are as follows:-
Q value for 3 mean = 3.006
Q value for 2 means = 2.858
Range value for 3 means = Q (0.189) = 3.006 x 0.189 = 0.568
Range value for 2 means = Q (0.189) = 2.858 x 0.189 = 0.540

The three mean range value was applied to the means with the greatest difference between them, 8.05 and 6.75, since these values covered the range over 3 means. The difference 1.3 is greater than 0.568. These two means, therefore significantly different.

The next comparison was between the means 8.05 and 7.7, using the 2 mean range value (0.540). Since the difference between the means (8.05 – 7.7 = 0.35) was less than 0.540, these two means were not significantly different. The next highest mean was then compared with the lowest mean and the difference was compared to the range value for 3 means.

7.7 – 6.75 = 0.95 > 0.568. These two means are significantly different.

The significant difference among the means are presented by using letters. Means followed by different letters were significantly different at the 5% level of probability.

Fish ball samples	C	B	A
Treatment means	8.05a	7.7a	6.75b

Fish ball sample 'C' and 'B' were liked significantly more than the other sample 'A'. Sample B and C were equally liked.

Fish Ball Sample 'B' and 'C' were prepared from *Oreochromis niloticus* by Formulation-II (72.5% boiled fish muscle, 20% boiled potato, 2.5% corn flour, 5% egg+salt+spices). Sample 'A' was prepared from

Oreochromis niloticus by Formulation-I (82.5% boiled fish muscle, 10% boiled potato, 2.5% corn flour, 5% egg + salt + spices).

A learned Panel member expressed his opinion in the following way:

So far I remember, I have found the products of 18/7/2020 better compared to the products of 18/3/2020. Because of the following reasons

1. The chewiness was better
2. Minimum broken part.
3. Less fishy order.

CONCLUSION

On the basis of this research the following conclusions may be drawn:

1. It is possible to prepare New Fishery Product e.g. Fish Ball from indigenous freshwater fishes of Bangladesh.
2. Nutritional composition, freshness, quality, safety in terms of heavy metal concentration of indigenous freshwater fish e.g. *Pangasius pangasius*, *Oreochromis niloticus* is excellent. A few exceptions of heavy metal concentration was obtained.
3. Consumer's preference is influenced by fish species, formulation i.e ingredient proportion, cooking process i.e. frying time.
4. Usual fishy odour in conventional products can be reduced or completely removed by using some ingredients e.g. boiled potato, spices, wheat flour, corn flour etc.
5. Fish Ball prepared by different formulations from *Pangasius pangasius* and *Oreochromis niloticus* were liked by the Panel Members of Taste panel of this research. All types of Fish ball were accepted by the Panel members although the degree of liking varied among the products.

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