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Physical quality and composition of ready-to-eat emulsion sausages prepared from mince of Indian major carps

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Abstract
The study was performed to develop emulsion fish sausages from Indian major carps as a ready to eat products in commensurate with demands of the existing consumer. The mince of Indian major carps (Catla, Rohu and mrigal) was utilized for development of emulsion sausages. The prepared sausages were heat processed at 40 °C for 30 min in a water bath followed by 90 °C for 20 min and kept in refrigerator overnight before analysis. The pH of the emulsion sausages varied between 6.63 and 6.81 suggests minimum degradation of important constituents of nutrients. The prepared sausages showed cooking yield from 83.66 to 87.77% and emulsion stability in the range of 4.60 to 6.69%. The highest expressible Moisture content (2.76%) was recorded in *Labeo rohita* as a consequence of low cooking yield. The moisture and protein content were ranged in between 70.62 to 71.26% and from 15.16 to 15.52 in the emulsion sausages of Indian major carps. Higher fat content in the present study was due to addition of oil for development of emulsion sausages. Overall, physical quality and proximate composition supports nutritious sausages at the hands of consumer. The study confirmed that white fleshed mince of Indian major carps could be effectively used for growth of ready-to-eat products in the form of sausages to suit ever changing life style of population.

Keywords: Indian major carps, sausages, emulsion, cooking yield, proximate, sensory

Introduction
The application of new approaches in the field of fish food technology for the production of foodstuffs to the people is the main goal of fish food industry contributing to human health nutrition. The fast-changing life styles urged people to consume more ready-to-eat products. In this view, sausages are one of the most favorite products of animal meat due to its taste and flavors [1]. However, consumption of animal red meat products containing higher saturated, unhealthy fats, salt, cholesterol and their adverse effects on health such as obesity, cardiovascular diseases, etc. could be seen among consumer in the recent years [2]. Therefore, sausages from white meat fish could be an alternative way to avoid adverse health effects from consumption of meat products. Fish sausages are an emulsion-based fish items made by blending the fish mince with salt to solubilize the protein and added with different additives (sugar, sodium tri-polyphosphate, monosodium glutamate), spices, seasonings, starch and oil and stuffed in to the casing (natural/synthetic) and heat processed (90 °C for 45 min), chilled (5-8 °C) and are made ready to eat after re-boiling (1 min) [3].
Indian fisheries sector is growing at 6-8% per annum. Among fish productions in India, Indian major carps are the main species utilized for human consumption in fresh form. The production of Indian major carps surpassed consumption. Hence, the surplus production Indian major carps can be converted into high valued sausages for consumption as ready-to-eat products.
The most of the sausages have been prepared from marine fish and very few attempts have been made on the development of fish sausages from freshwater fish, Indian major carps. The Indian major carps are compatible species for development of fish sausages due to its white flesh, low fat, etc. but have disadvantage of being containing high pin bones.
Taking advantage of Indian major carps altogether, the objective of the study is to substantiate the possibilities of the preparation of emulsion sausages from Indian major carps (*Labeo catla*, *Labeo rohita* and *Cirrhinus mrigala*) for consumption as a ready-to-eat products.

Materials and Methods

Raw material

Fresh catla, rohu and mrigal were purchased from a local market (Dadar, Mumbai, Maharashtra) and brought to the laboratory of Post-Harvest Technology, Central Institute of Fisheries Education, Mumbai, Maharashtra in (1:1) iced condition during 2018-2019. On arrival, the fish were immediately beheaded, gutted, descaled and manually filleted. The mince of catla, rohu and mrigal was prepared from processed fish using a deboning machine (Baader 694, Lubeck, Germany) with a counter-rotating belt and drum mechanism. Dressed fishes were fed into the drum sieve having 5 mm diameter holes and the mince was prepared. The temperature was maintained below 10 ºC throughout the process. The obtained mince was sealed in polythene pouches (LDPE) separately and kept in refrigerator (4 °C) until the preparation of sausage.

Preparation of sausages

The sausages were prepared by grinding the 65% (w/w) mince of each species with 19.15% (w/w) ice water with 1.6% (w/w) sodium chloride (NaCl), 0.25% (w/w) sodium tri-polyphosphate (STPP) and 1% (w/w) sugar for 3 minutes in a pre-cooled silent cutter. The temperature was maintained below 10 °C throughout the process. The ingredients mixed mince of each species again comminuted by slow addition of 8% (w/w) sunflower oil using silent cutter for 3 min and finally corn starch at the level of 5% (w/w) was blended further for 3 min. The blended mince was filled manually using hand stuffer into krehalon casing of 2.5 cm diameter. The care was taken to eliminate the trapped air as much as possible during manual filling of mince in sausage casings. The ends of the tubes were tied and pre-incubated at 40 °C for 30 min followed by heating in a temperature-controlled water bath at 90 °C for 20 minutes. The formed sausages were immediately cooled in iced water and stored in refrigerator (4°C) overnight before further analysis.

Determination of pH

The 10 g samples from sausages of each species before and after cooking were mixed separately with 50 mL of distilled water in a homogenizer (Polytron system PT 2100, Germany) for 30 seconds and pH value of the homogenates was measured with a digital pH meter (Eutech tutor pH/ºC meter, Eutech Instruments, Singapore) previously standardized by buffers of pH 4.8 and 9.2.

Determination of cooking yield (%)

A sausage emulsion of known weight was heated at 90 °C for 4 min using a water bath (Huber, Germany) for calculation of cooking yield [4]. Cooking yield (%) of emulsion was calculated as

$$\text{Cooking yield (\%)} = \frac{\text{Weight of boiled sausages}}{\text{Weight of uncooked sausages}} \times 100$$

Emulsion stability (%)

The emulsion stability (ES) is expressed as total expressible fluid. A known weight of (approximately 30 g) of sausage emulsion was transferred into a centrifuge tube followed by centrifugation at 3600 g for 1 min [5]. The centrifuged sample was heated at 70 °C for 30 min in a water bath followed by centrifugation at 3600 g for 3 min. The obtained supernatant was decanted and weight of the sediment was noted.

$$\text{Total expressible fluid (\%)} = \frac{\text{Weight of centrifuge tube and sample} - \text{Weight of centrifuge tube and pellet}}{\text{Sample weight}} \times 100$$

Determination of expressible moisture content (%)

The expressible moisture content (EMC) was estimated as the quantity of liquid squeezed from sausage gels upon an applied force.[6] A gel sample with a thickness of 0.5 cm was weighed (X) and placed between two layers at the top and three layers of Whatman filter paper No. 1 (Whatman International Ltd., Maidstone, England) at the bottom. The gels and papers were pressed and maintained for 2 min under applied force with a 5 kg weight. The samples were then removed and weighed again (Y). Expressible moisture content was calculated and expressed as the percentage of sample weight as follows.

$$\text{Expressible moisture content (\%)} = \{(X-Y)/X\} \times 100$$

Analysis of proximate composition

The proximate composition analysis of sausage samples (moisture, protein, crude fat and ash content) was performed using standard analytical methods.[7] Moisture content of the sausage samples was determined by direct heating at 100 ± 2 °C in a hot air oven for 18-24 h. The estimated total protein nitrogen content (micro-Kjeldahl method) was multiplied by 6.25 to determine protein content of sausage samples. The Soxhlet method was performed to measure crude fat content of sausage samples using petroleum ether (60-80 BP) as solvent. The measured sausages samples were incinerating at a temperature of 600 ± 5 ºC for 6 h in Phoenix Microwave furnace (CEM, UK) for determination of ash content. The mean values of the analysis were expressed as gram per 100 g in the present study.

Sensory analysis

Sensory characteristics of sausage samples were evaluated by 10 members' panel of Department of Post-harvest Technology, CIFE, Mumbai trained and familiar with sausage consumption. Sausages were cut into thin slices and served to panellists in white fiber plates for evaluation of sensory characteristics such as colour, odour, taste, texture, flavour, appearance and overall acceptability based on a 9-point hedonic scale [8]. Panel members were provided with sensory sheets having sensory characteristics and were asked to assign scores based on the following scale; 1, dislike extremely; 2, dislike very much; 3, dislike moderately; 4, dislike slightly; 5, neither like nor dislike; 6, like slightly; 7, like moderately; 8, like very much; 9, like extremely.

Statistical analysis

The data in triplicate obtained in the study were subjected to one-way analysis of variance (ANOVA). Duncans' Multiple Range Test (DMRT) was conducted to test the significance difference (95% level of confidence; $p<0.05$). The results are expressed as mean ± standard deviation.

Results and Discussion

The eating quality of ready-eat-products like emulsion sausages largely depend on composition and perceivable characteristics of the products.

Physical quality of sausages

The pH, cooking yield (%), emulsion stability (%) and expressible moisture content (%) of emulsion sausages prepared from Indian major carps are given in Table 1.

Table 1: Physical characteristics of emulsion sausages prepared from Indian major carps

Fish	*Labeo catla*	*Labeo rohita*	*Cirrhinus mrigala*
pH	6.81 ± 0.10^{b}	6.64 ± 0.01^{a}	6.63 ± 0.01^{a}
Emulsion stability (%)	5.16 ± 0.07^{a}	6.69 ± 0.40^{b}	4.60 ± 0.36^{a}
Cooking yield (%)	84.33 ± 0.51^{a}	83.66 ± 0.35^{a}	87.77 ± 0.43^{b}
EMC (%)	2.66 ± 0.18^{a}	2.76 ± 0.26^{a}	2.51 ± 0.06^{a}

Data (n=3) are expressed as mean (±SD). Different superscripts in the same column signify statistical difference (p<0.05)

Significant difference (p<0.05) was seen in pH of sausages made from different species of carps. The pH of sausages prepared from Indian major carps ranged between 6.63 and 6.81 suggested good quality raw material used for preparation of sausages. An initial pH value of 6.7 was recorded in silver carp sausages [9] and found in accordance with the present study.

The data of cooking yield (83.66 – 87.77%) also supports good gelling and emulsion capacity of proteins of different species in the present study. Adding sodium tripolyphosphate (STPP) (0.5%) in sausages reduced cooking losses [10]. The good cooking yield in the present study also indicated crosslinking of proteins and better gel network [11]. Results indicated that pre-emulsion of mince with sunflower oil and blending with corn starch resulted in increased emulsion stability due to reduction in expressible fluid as found in mrigal sausages. The stabilizing effect of corn starch resulted in better emulsion [12].

Emulsion stability is very most important quality characteristics of sausage. The preparation of emulsion sausages showed enhanced emulsion stability in the sausages simultaneously decreasing the expressible moisture content in sausages of different species of Indian major carps. The emulsion stability was found from 4.60 to 6.69% whereas, EMC ranged between 2.51 and 2.76% during the study. Significant difference (p<0.05) was observed in emulsion stability in sausages made from different species of Indian major carps. Expressible moisture content of mince muscles is an important indicator for changes in textural quality of sausages. The similar results were also noticed for Pangas sausages added with Pangas protein isolate [13]. The loss in three-dimensional structure of protein due to aggregation and irreversible denaturation results in lower water holding capacity. Gel forming ability and emulsifying capacity of myofibrillar proteins depends on the water holding capacity of muscle proteins [14]. The variation in expressible moisture content in sausages made from different species is related to type of meat and textural characteristics [15].

Proximate composition of sausages

Proximate composition of sausages prepared from catla, rohu and mrigal is depicted in Table 2.

Table 2: Proximate composition of emulsion sausages prepared from Indian major carps

Fish	*Labeo catla*	*Labeo rohita*	*Cirrhinus mrigala*
Moisture (%)	71.23 ± 0.11^{b}	70.62 ± 0.13^{a}	71.26 ± 0.20^{b}
Protein (%)	15.52 ± 1.92^{a}	15.21± 0.37^{a}	15.16 ± 0.27^{a}
Fat (%)	10.75 ± 0.20^{a}	11.73 ± 0.0^{c}	11.09 ± 0.10^{b}
Ash (%)	2.50 ± 0.05^{a}	2.44± 0.03^{a}	2.47 ± 0.03^{a}

Data (n=3) are expressed as mean (±SD). Different superscripts in the same column signify statistical difference (p<0.05)

Sausages from different species of Indian major carps had moisture content ranging between 70.62 and 71.26% and significant difference (p<0.05) was found in the moisture content of sausages among species of Indian major carps. The difference in moisture content of raw materials attributed to significant differences in moisture content of sausages from species of Indian major carps. The amount of protein content present in fish is generally responsible for final texture of the product. In this study, the protein content ranged from 15.16 to 15.52%. Protein content (p>0.05) was found to be inversely proportional to the moisture content. Fish proteins are highly digestible proteins contains essential amino acids and nutritional value of sausages are indicated by protein content. In the present study, the amount of moisture and protein content in the Indian major carps' mince sausages were found lower than those reported for mince gels of Indian major carps due to addition of different ingredients during preparation of sausages [16]. Incorporation of oil in the preparation of emulsion sausages significantly (p<0.05) increased content of fat of the prepared sausages. The fat content ranged between 10.75 and 11.73% and found inversely proportional to moisture content. Ash content is the result of mineral composition of fish and fish products and found to vary non-significantly (p>0.05) between 2.44 to 2.50%. The leaching of salts and other minerals during processing of products resulted in cooking loss [17]. The higher ash content in the catla may be the result of higher pin bones in the fish. The corn starch in the present study might also have contributed to the ash content of the sausages.

Sensory quality characteristics of sausages

The sensory quality characteristics of emulsion fish sausages prepared from fresh Indian major carps are shown in Fig. 1 and overall acceptability of sausages are presented in Fig. 2.

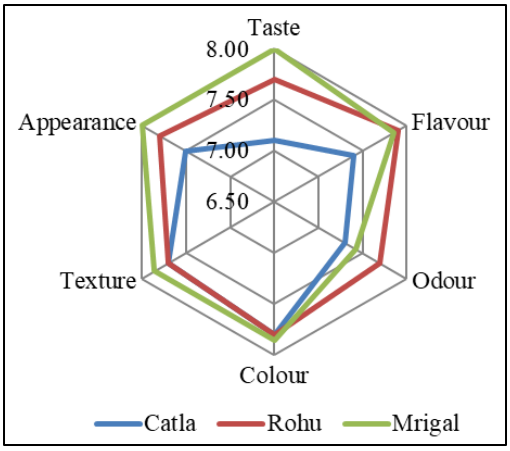

Fig 1: Sensory characteristics of emulsion sausages prepared from Indian major carps on 9-point hedonic scale (n=10)

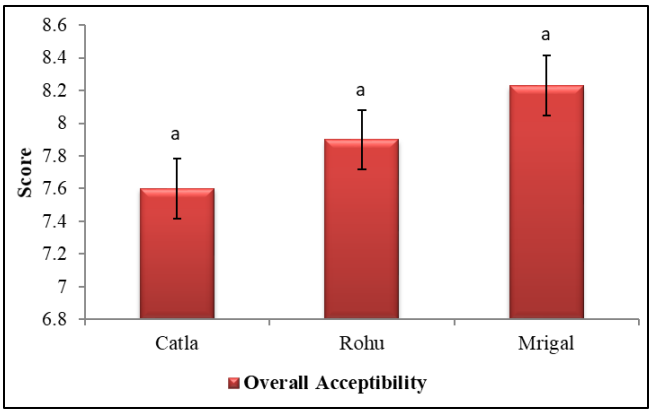

Fig 2: Overall acceptability score of emulsion sausages prepared from Indian major carps on 9-point hedonic scale (n=10)

The significant differences in sensory characteristics of sausages of Indian major carps were not observed during the study. Among Indian major carps, except odour (7.30) higher score for appearance (8.00), taste (8.00), colour (7.86) and texture (7.86) was recorded for sausages from mrigal fish followed by for rohu and catla sausages. This was greatly attributed to white colour of mince of mrigal fish and characteristics of muscle. The freshness of fish and water holding capacity of mince were the main attributes responsible for present score of sensory quality of sausages [18]. The freshness of fish is also an important criterion for development of gel-based products like sausages. The heat treatment could have improved gelling ability of muscle, resulted in better quality of sausages from mrigal fish which was perceived by panelists. Significant differences (p>0.05) in overall acceptability scores of sausages made from Indian major carps were not observed in ANOVA analysis. The overall acceptability score was ranged between 7.60 for catla, 7.90 for rohu and 8.23 for mrigal sausages This could be due to overall liking of consumers towards rohu fish and white coloured flesh of mrigal fish. Moisture content of the muscle generally responsible for textural changes in the sausages [15]. The appropriate amount of oil addition in mince sausages demonstrated superior score for texture in sausages made from Indian major carps [19]. The present study suggests that the texture of prepared emulsion fish sausages using mrigal was found marketable to consumer. The sausages made under study were rated as 7'like moderately to like very much'.

Conclusion

In conclusion, emulsion sausages from Indian major carps were successfully developed. The different species of Indian major carps were not found to significantly affect the quality of prepared sausages. Small changes in quality of sausages were expected due to different body composition of catla, rohu and mrigal and freshness of raw material. In general, all species of Indian major carps were found to be compatible for development of emulsion sausages on commercial scale. Further study is recommended on improvement in storage stability of mince sausages at refrigerated and frozen temperature.

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References

1. Souissi N, Jridi M, Nasri R, Slama RB, Njeh M, Nasri M. Effects of the edible cuttlefish gelatin on textural, sensorial and physicochemical quality of octopus sausage, LWT-Food Science and Technology. 2016;65:18-24.
2. Josquin NM, Linssen JP, Houben JH. Quality characteristics of Dutch-style fermented sausages manufactured with partial replacement of pork back-fat with pure, pre-emulsified or encapsulated fish oil, Meat Science. 2012;90(1):81-86.
3. Elavarasan K. Fish sausage- a ready to eat product. In: Training manual on seafood value addition. Sreelakshmi, K. R., Elavarasan, K., Mohan, C. O., Ashok Kumar, K. (Eds.), ICAR-Central Institute of Fisheries Technology, Cochin, India; c2018. p. 49.
4. Murphy EW, Criner PE, Gray BC. Comparisons of methods for calculating retentions of nutrients in cooked foods, Journal of Agricultural and Food Chemistry. 1975;23(6):1153-1157.
5. Hughes E, Cofrades S, Troy DJ. Effects of fat level, oat fibre and carrageenan on frankfurters formulated with 5, 12 and 30% fat, Meat Science. 1997;45(3):273-281.
6. Ng CS. Measurement of free and expressible drips. In: Laboratory manual on analytical methods and procedure for fish and fish products, Hasegawa, H. (Ed.) Marcel Dekker, New York, USA, 1978, 1-2.
7. AOAC. Official methods for analysis of AOAC International, 18th edn. Association of Official Analytical Chemists, Washington, DC; c2005.
8. Mailgaad M, Civille GV, Carr BT. Sensory evaluation techniques, CRS Press, Boca Raton, FL, 1999, 416.
9. Xu Y, Xia W, Yang F, Nie X. Physical and chemical changes of silver carp sausages during fermentation with *Pediococcus pentosaceus*, Food Chemistry. 2010;122(3):633-637.
10. Trius A, Sebranek JG, Rust RE, Carr JM. Carrageenans in beaker sausage as affected by pH and sodium tripolyphosphate, Journal of Food Science. 1994;59(5):946-951.
11. You S, Yang S, Li L, Zheng B, Zhang Y, Zeng H. Processing technology and quality change during storage of fish sausages with textured soy protein, Foods. 2022;11(22):3546.
12. Fogaça FH, Sant'Ana LS, Lara JAF, Mai ACG, Carneiro DJ. Restructured products from tilapia industry by products: The effects of tapioca starch and washing cycles, Food and Bioproducts Processing. 2014;94:482-488.
13. Surasani VKR, Raju CV, Shafiq U, Chandra MV, Lakshmisha IP. Influence of protein isolates from Pangas processing waste on physico-chemical, textural, rheological and sensory quality characteristics of fish sausages, LWT-Food Science and Technology. 2020;117:108-662.
14. Santana P, Huda N, Yang TA. Physicochemical properties and sensory characteristics of sausage formulated with surimi powder, Journal of Food Science and Technology. 2015;52:1507-1515.
15. Dincer MT, Çakli Ş. Textural acceptability of prepared fish sausages by controlling textural indicators, Turkish

Journal of Veterinary & Animal Sciences. 2015;39(3):364-368.
16. Gore SB, Balange AK, Nayak BB, Kumar HS, Tandale AT, Xavier KM. Comparative analysis of unwashed and single washed mince gel from Indian major carps, Journal of Food Science and Technology, 2021, 1-11.
17. Chattopadhyay K, Martin Xavier KA, Layana P, Balange AK, Nayak BB. Effect of chitosan hydrogel inclusion on centesimal composition of pangasius (*Pangasianodon hypophthalmus*) (Sauvage, 1878) emulsion sausages under refrigerated storage, 2020.
18. Chattopadhyay K, Martin Xavier KA, Balange AK, Layana P, Nayak BB. Chitosan gel addition in pre-emulsified fish mince - Effect on quality parameters of sausages under refrigerated storage, LWT - Food Science and Technology. 2019;110:283-291.
19. Chuapoehuk P, Raksakulthai N, Worawattanamateekul W. Process development of fish sausage, International Journal of Food Properties. 2001;4(3):523-529.