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Development of Seaweed (*Padina tetrastromatica*) incorporated Mince Sausage from Common Carp (*Cyprinus carpio*), reared in Inland Saline Water

Dharani M. and Amjad Khansaheb Balange*

Fisheries Resources, Harvest and Post-Harvest Management Division, ICAR-Central Institute of Fisheries Education, Mumbai, India

Abstract

The study was conducted for the development of seaweed based value-added product from inland saline water-reared common carp fish mince. Three concentrations of seaweed powder (0.5%, 1%, and 2%) were used. The addition of 2% *P. tetrastromatica* powder to mince showed better results as compared to other treatments. Compared to control sausages with 0% seaweed inclusion, the common carp mince sausages with 2% seaweed powder addition had greater hardness values and ash content. Additionally, the sensory scores of the sausages that contain seaweed powder were satisfactory. Therefore, seaweed powder can be utilised as a potential component to enhance the dietary value and textural properties of fish mince sausages. Furthermore, developing value-added products will boost the market value of fish raised in inland saltwater, which are underutilised resources with a significant potential to expand aquaculture production.

Keywords:
Padina tetrastromatica, inland saline aquaculture, *Cyprinus carpio*

***Corresponding author:**
amjadbalange@cife.edu.in

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Introduction

In 2020, common carp *(Cyprinus carpio)* accounted for 8.6% (4.24 million tonnes) of total finfish aquaculture production (49.12 million tonnes) and ranked fourth in terms of global finfish aquaculture production, preceded by grass carp *(Ctenopharyngodon idella)*, silver carp (*Hypophthalmichthys molitrix*), and Nile tilapia (*Oreochromis niloticus*) (SOFIA, 2022). In Asia, common carp is raised using several aquaculture techniques, the most popular being the semi-intensive pond polyculture system (SOFIA, 2012). Soil salinity has adversely affected approximately 8.62 million hectares of agricultural land in India. Haryana, Uttar Pradesh, Punjab, and Rajasthan have over 40% of the total saline soils in inland areas (Lakra *et al*., 2014). Inland saline aquaculture refers to farming practices in ponds built in saline-affected regions unsuitable for agriculture (Trendall and Pitman, 1998). Since common carp can withstand wide variations in salinity and temperature, one of the finest candidate species for aquaculture in salinity-affected lands (Whiterod and Walker, 2006).

Global algae production in the year 2020 was 36 million tonnes with algae culture accounting for 97.4% of the total production. The trade value of algae was 1.1 billion USD, with China being the largest exporter. Marine macroalgae, known as seaweed, dominate global algae farming. Seaweeds are considered as a nutritious food, generally

low in fat and calorie. They contain variety of critical nutrients such as Omega-3 and Omega-6 polyunsaturated fatty acids, vitamins, iodine, and dietary fiber. Seaweed consumption is connected with various positive health effects, including decreasing blood pressure, reducing the risk of strokes etc. (Fitzgerald *et al.,* 2011). Seaweed is one of several sustainable options that could help ensure global food security because of the growing global population and ecological challenges (Cai *et al.,* 2021). Since seaweed are cultured in seawater, the need for agricultural land and freshwater supply is also reduced.

Due to the presence of intramuscular bones and smell, economic value and consumer acceptance are low in carps (Abdel-Aal *et al*., 2014; Ninawe and Rathnakumar, 2008). Value-added products are well-accepted and highly preferred in the domestic as well as global market. Common carp can be processed into suitable value-added products to boost their acceptability and usage. Additionally, the incorporation of seaweed in fish products will give enormous health benefits to consumers. To enhance the nutritional, textural, and organoleptic properties of many meat products, including those made from pork, beef, poultry, and seafoods, as well as bakery products, seaweed has been used (Roohinejad *et al.*, 2017). In addition, sausages showed improvement in the nutritional quality after the addition of seaweed. In this study, seaweed powder from the brown seaweed *Padina tetrastromatica*, which is found along the Indian coast, is added to fish mince sausages to improve textural characteristics and provide nutritional value.

Materials and methods

Raw materials and chemicals

Common carp (*Cyprinus carpio*) cultured in inland saline water with a salinity of 4 ppt was captured from the Rohtak district in Haryana, India and brought to the laboratory by air transport. The fish was dressed, washed, minced and stored frozen at -20°C for three months in polyethene bags. From the Mandapam coast of the Gulf of Mannar area in the Ramanathapuram district of Tamil Nadu, seaweed (*Padina tetrastromatica*) was harvested. Seaweed was cleaned in fresh water after being harvested and dried in sunlight. After that, the semi-dried form was brought to the lab. To get rid of any adhering items like shells, sand, stones, and other undesired objects, it was rinsed in fresh water. After being dried for 7 hours at 50° C in a mechanical dryer, it was ground into a fine powder and kept at room temperature in an airtight container for future work. Analytical grade chemicals purchased from Hi-media (Mumbai, India), Merck (Mumbai, India), Sigma Aldrich (Bangalore, India), and Qualigens (Mumbai, India) were used for the work.

Proximate composition of seaweed powder *(Padina tetrastromatica)*

AOAC (2005) methods were used to determine the proximate composition of the seaweed powder. The moisture content was estimated using a hot air oven. The protein content was analysed using a Kjeldhal nitrogen analyser (Kelplus-KES12L VAI, Pelican, India). The crude fat content was determined using the Soxhlet (EXPO HI-TECH Soxhlet extraction heater mantle type, Mumbai, India) apparatus, and the ash content was determined using a muffle furnace (EXPO HI TECH, i-therm AL-7941, Mumbai, India). The final values obtained were converted into a wet weight basis.

Preparation of fish *(Cyprinus carpio)* mince sausages

The frozen mince was thawed in water, and the control sausage (C-0% seaweed) was prepared according to Maheshwara *et al.* (2008). The following ingredients were used to make the sausages: 70% mince, 2.5% salt, 1.5% sugar, 0.25% STPP, 0.25% potassium sorbate, 0.60% chilli powder, 0.20% pepper powder, 0.30% coriander powder, 0.40% ginger garlic paste, 10% tapioca starch, 4% vegetable oil, and 10% chill water. The amount of starch was adjusted to add seaweed powder at three different concentrations such as 0.5% (T1), 1% (T2), and 2%(T3). Using a food processor, the ingredients were mixed, and with the addition of chilled water, the batter's temperature was kept below 15°C. With the help of a plastic sausage stuffer, the sausage batters were filled into polyvinylidene casings (diameter: 4 cm, length: 15 cm). The stuffed sausages were cooked at 40°C for 30 minutes and then 90°C for 20 minutes. They were further cooled in ice water and kept in a refrigerator overnight at 4°C for further study.

Sensory analysis

Eight-panel members (n=8) including scientists and students from the post-harvest technology section of ICAR-CIFE, Mumbai conducted the sensory evaluation. The 9-point hedonic scale method, with scores ranging from 1 to 9, was used to perform the sensory study one representing the lowest and 9 representing the most significant score.

Texture profile analysis

Textural parameters, including hardness, cohesiveness, elasticity, and adhesiveness, were tested with a texture analyser (TX-700 Lamy rheology, France). A cylindrical probe with a 50 kg lead cell and 5 cm diameter was used to compress samples. The sample size was 2.5 cm in height and 2 cm in diameter. The texture analysis was carried out with the following parameters: a height of 40%, a deformation rate of 1 mm/s, a down speed of 1 mm/s, a force to start of 0.5 N, a wait position of 5 m, a delay of 5 s and an up speed of 1 mm/s.

Statistical analysis

All the experiments were done in triplicates. The SPSS 16.0 statistical programme (SPSS, 2000) was used for the statistical evaluation of results. The statistical significance ($p \leq 0.05$) among the triplicates was determined by Duncan's multiple-range test. The results were given as mean ± standard deviation.

Results and discussion

Proximate composition of seaweed (*Padina tetrastromatica*) powder

Both fresh and dried seaweeds contain dietary benefits which can be utilised as an essential ingredient in food formulations. The proximate composition of seaweeds is used to assess their nutritional qualities (Mabeau and Fleurence, 1993). The proximate composition of seaweed powder is given in Table 1. The moisture, fat, protein, and ash content of seaweed powder was 13.17%, 0.94%, 13.31%, and 29.12%, respectively. The results are closely related to the findings of Khan et al. (2016). They recorded 15.68% moisture, 0.98% lipid, 12.29% protein, and 27.95% ash in *Padina tetrastromatica*. However, Mwalugha *et al*. (2014) reported 10.22% moisture, 2.48% fat, 9.86% fibre, 7.16% protein, and 18.36% ash content in *Padina tetrastromatica*. This might be because, the nutritional value of seaweed varies depending on the species, temperature, season, and location (Kaehler and Kennish, 1996).

Table 1. Proximate composition of seaweed (*Padina tetrastromatica*) powder

Composition	*Padina tetrastromatica*
Moisture (%)	13.71±0.31
Protein (%)	13.31±0.0.76
Fat (%)	0.94±0.04
Ash (%)	29.12±0.29
Data expressed as mean± SD (n=3)	

Effect of seaweed powder on the sensory parameters of fish mince sausages

Consumers will accept or reject a food product based on their overall impression of appearance, texture, odour, and flavour of food, all of which are framed within a broad sense of quality; this is the type of information that physical and chemical studies cannot provide. As a result, sensory evaluation became an important part of any research project concerned with product development (Penfield *et al*., 1990). The sensory score of seaweed powder (SP) incorporated sausages T1 (0.5% SP), T2 (1% SP), and T3 (2% SP), and control sausages (0% SP) made with inland saline water reared common carp (ISWCC) mince is shown in Table 2. The sensory scores of the control sausages (C) were higher than those of the treatment sausages. As the concentration of seaweed increased, the scores decreased. However, the results were within the acceptable range. According to the findings, no significant variation ($p>0.05$) was found in the sensory parameters between C and T1. A significant difference ($p<0.05$) was found among C, T2, and T3. T1 (0.5% SP) yielded the highest score for overall acceptability (8.01) among the treatment sausages. However, incorporating SP in T2 and T3 affected all the sensory scores. The overall acceptability significantly decreased for T2 (7.71) and T3 (7.05).

Consumers' acceptance of *Padina tetrastromatica* in sausages made from inland saline water-reared common carp fish mince decreased with increasing seaweed concentration. According to Kim *et al*. (2010), the type of food in which seaweed is utilized is the most critical factor influencing sensory parameters. This is shown by the current study, which discovered that consumer response varied depending on the amount of *P. tetrastromatica* in the fish sausages. Kim *et al*. (2010) found similar outcomes. They observed that using sea tangle powder in fish sausages reduced colour scores, and all treatments obtained lower sensory values than the control. Kim *et al*. (2010) also reported that consumers who value well-being will not be concerned about colour and other sensory parameters of the food products which are nutritionally important. Therefore, fish sausages containing seaweed will be accepted by consumers.

Data expressed as mean± SD (n=8), the mean value in the same row with different superscripts are significantly different ($p<0.05$); C- Control sausage with 0% seaweed, T1- Sausage with 0.5% seaweed, T2- Sausage with 1% seaweed, T3- Sausage with 2% seaweed.

Table 2. Sensory scores of seaweed-incorporated fish mince sausage

Parameters	C	T1	T2	T3
Appearance	8.21±0.25a	8.01±0.16ab	7.81±0.21bc	7.51±0.32c
Colour	8.25±0.22a	7.96±0.20a	7.56±0.38b	7.46±0.34b
Texture	8.00±0.16a	8.10±0.29a	8.20±0.27a	8.25±0.25a
Odour	8.04±0.10a	7.90±0.29ab	7.66±0.15b	7.20±0.21c
Taste	8.00±0.13a	7.86±0.22ab	7.55±0.37bc	7.25±0.35c
Flavour	8.13±0.25a	7.85±0.22a	7.50±0.31b	7.24±0.18b
Overall acceptability	8.25±0.22a	8.01±0.16a	7.71±0.21b	7.05±0.11c

Data expressed as mean± SD (n=8), the mean value in the same row with different superscripts are significantly different (p<0.05); C- Control sausage with 0% seaweed, T1- Sausage with 0.5% seaweed, T2- Sausage with 1% seaweed, T3- Sausage with 2% seaweed.

Table 3. Texture profile of fish mince sausages

Parameters	C	T1	T2	T3
Hardness (N)	4.65±0.63a	4.59±0.26a	4.97±0.10a	5.76±0.31b
Cohesiveness	1.08±0.09a	1.06±0.02a	1.01±0.03ab	0.94±0.04b
Elasticity	1.27±0.05a	1.28±0.02a	1.25±0.02a	1.23±0.02a

Data expressed as mean± SD (n=3), the mean value in the same row with different superscripts are significantly different ($p<0.05$); C- Control sausage with 0% seaweed, T1- Sausage with 0.5% seaweed, T2- Sausage with 1% seaweed, T3- Sausage with 2% seaweed.

Effect of seaweed powder on the texture profile of fish mince sausage The texture profile analysis of sausages made with inland saline water-reared common carp fish mince is shown in Table 3. The seaweed was included in the sausages at three different concentrations: 0.5% (T1), 1% (T2), and 2% (T3). Seaweed was not used to produce the control sausages (C). The results indicated that textural parameters such as hardness, cohesiveness, and elasticity did not differ significantly ($p>0.05$) among C, T1, and T2. The hardness and cohesiveness values differed significantly ($p<0.05$) between C and T3. The hardness value of T3 (5.76 N) was higher than that of C (4.65 N). The elasticity values between C and T3 did not change significantly ($p>0.05$). T3 (0.94) had low cohesiveness value than C (1.08). According to the present study, seaweed incorporation at the level of 2% can improve the texture of sausages made from inland saline water reared common carp fish mince since seaweed can enhance the textural parameters of fish sausages by retaining more water in the sausages (Aleson-Carbonell *et al*., 2005). The hardness of meat products could increase due to higher dietary fiber content of seaweed (Fernandez-Gines *et al.*, 2004). Additionally, *Kappaphycus alvarezii*, a species of red algae, was found to improve the hardness of chicken meat sausages by Pindi *et al*. (2017).

Proximate composition of seaweed-incorporated fish mince sausages

The proximate composition of sausages made from common carp mince reared in inland saline water (Table 4). Since T3 showed an increase in the textural parameters, it was used in the comparative proximate analysis with control. There was no significant difference ($p>0.05$) in moisture, protein, and fat content between C and T3. The ash content of C (1.01%) and T3 (1.89%) was found to be significantly different ($p<0.05$). Similar results were found by Mohammad *et al*. (2019). They incorporated *K. alvarezii* at three concentrations: 10%, 20%, and 30% in fish sausages. They recorded 1.51% ash content in the control sausages (0% seaweed addition), and the ash content was increased with an increase in the concentration of seaweed addition: 2.05% (10%), 2.15% (20%), and 2.36% (30%). There was no significant difference ($p>0.05$) found in the protein and fat content between control and treatment sausages. Kim *et al.* (2010) also recorded similar results. The current study suggests that the increase in the ash content can be obtained in sausages made from inland saline water-reared common carp fish mince when the seaweed *Padina tetrastromatica* is added at the level of 2% and more.

Table 4. Proximate composition of fish mince sausages

Parameters	C	T3
Moisture (%)	73.65±0.07a	74.06±0.12a
Protein (%)	16.31±0.06a	16.76±0.25a
Fat (%)	5.18±0.13a	5.35±0.05a
Ash (%)	1.01±0.08a	1.89±0.05b

Data expressed as mean± SD (n=3), the mean value in the same row with different superscripts are significantly different ($p<0.05$); C- Control sausage with 0% seaweed, T3- Sausage with 2% seaweed.

Conclusion

Adding seaweed (*Padina tetrastromatica*) powder to sausages made from inland saline water-reared common carp (*Cyprinus carpio*) fish mince improved the textural parameters and ash content compared to the control sausages. The sensory parameters were also in the acceptable range. Therefore, seaweed can be utilised as a potential supplement to enhance the texture characteristics of fish mince sausages and boost their nutritional value. Further work can be carried out to find the storage stability and to study their quality changes during low-temperature storage.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Abdel-Aal, H.A., Mohamed, H.M.A., Hammam, A.M. and Elhosan, R.M., 2014. Physical, chemical and sensory evaluation of common carp fish (*Cyprinus carpio*) surimi. In *4th Conference of Central Laboratory for Aquaculture Research*, 409-425.

Aleson-Carbonell, L., Fernandez-Lopez, J., Perez-Alvarez, J.A. and Kuri, V., 2005. Characteristics of beef burger as influenced by various types of lemon albedo. *Innovative Food Science & Emerging Technologies*, *6*(2): 247-255.

AOAC, 2005. AOAC Official Methods of Analysis. 16th ed., Association of Official Analytical Chemists, Washington, DC.

Cai, J., Lovatelli, A., Aguilar-Manjarrez, J., Cornish, L., Dabbadie, L., Desrochers, A., Diffey, S., Garrido Gamarro, E., Geehan, J., Hurtado, A. and Lucente, D., 2021. Seaweeds and microalgae: an overview for unlocking their potential in global aquaculture development. *FAO Fisheries and Aquaculture Circular*, 1229.

Fernandez-Gines, J.M., Fernandez-Lopez, J., Sayas-Barbera, E., Sendra, E. and Perez-Alvarez, J.A., 2004. Lemon albedo as a new source of dietary fiber: application to bologna sausages. *Meat Sci*ence, 67(1): 7-13.

Fitzgerald, C., Gallagher, E., Tasdemir, D. & Hayes, M. 2011. Heart health peptides from macroalgae and their potential use in functional foods. *Journal of Agricultural and Food Chemistry*, 59(13): 6829-6836.

Kaehler, S. and Kennish, R., 1996. Summer and winter comparisons in the nutritional value of marine macroalgae from Hong Kong. *Botanica marina*, 39: 11-17.

Khan, M.S.K., Hoq, M.E., Haque, M.A., Islam, M.M. and Hoque, M.M., 2016. Nutritional evaluation of some seaweeds from the Bay of Bengal in contrast to inland fishes of Bangladesh. *IOSR J. Environ. Sci. Toxicol. Food Technol*, 10(11): 59-65.

Kim, H.W., Choi, J.H., Choi, Y.S., Han, D.J., Kim, H.Y., Lee, M.A., Kim, S.Y. and Kim, C.J., 2010. Effects of sea tangle (*Lamina japonica*) powder on quality characteristics of breakfast sausages. *Food Science of Animal Resources*, 30(1): 55-61.

Lakra, W.S., Reddy, A.K. and Harikrishna, V., 2014. Technology for commercial farming of Pacific white shrimp *Litopenaeus vannamei* in inland saline soils using ground saline water. *CIFE Technical Bulletin,* 1: 1-28.

Mabeau, S. and Fleurence, J., 1993. Seaweed in food products: biochemical and nutritional aspects. *Trends in Food Science & Technology*, 4(4):103-107.

Maheshwara, K.J., Naik, J., Balamatti, A. and Jagadish, T.D., 2017. Biochemical and shelf life study of quality of fish sausage in ambient and refrigerated storage. *Biochemical & Cellular Archives*, 17(1): 265-270.

Mohammad, S.M., Razali, S.M., Rozaiman, N.M., Laizani, A.N. and Zawawi, N., 2019. Application of seaweed (*Kappaphycus alvarezii*) in Malaysian food products. *International Food Research Journal*, 26(6): 1677-1687.

Mwalugha, H., 2014. Preliminary studies on the proximate composition of some selected seaweeds from Mkomani and Kibuyuni, Kenya. In *Scientific Conference Proceedings*.

Ninawe AS, Rathnakumar K., 2008. Fish processing technology and product development. Mumbai (India): Narendra Publishing House, 364–365.

Penfield, M.P., Campbell, A.M. and Penfield, M.P., 1990. *Experimental food science*, San Diego, CA: Academic press, 294-330.

Pindi, W., Mah, H.W., Munsu, E. and Ab Wahab, N., 2017. Effects of addition of *Kappaphycus alvarezii* on physicochemical properties and lipid oxidation of mechanically deboned chicken meat (MDCM) sausages. *British Food Journal*, 119(10): 2229-2239.

Roohinejad, S., Koubaa, M., Barba, F.J., Saljoughian, S., Amid, M. and Greiner, R., 2017. Application of seaweeds to develop new food products with enhanced shelf-life, quality and health-related beneficial properties. *Food Research International*, 99: 1066-1083.

SOFIA, 2012. The State of World Fisheries and Aquaculture 2012. FAO Technical publication, Rome, Italy.

SOFIA, 2022. The State of World Fisheries and Aquaculture 2022. FAO Technical publication, Rome, Italy.

Trendall, J. and Pitman, D.R., 1998. The outback ocean: A resource assessment and industry development options for aquaculture using inland salt water. *Fisheries Western Australia, Perth*.

Whiterod, N.R. and Walker, K.F., 2006. Will rising salinity in the Murray–Darling Basin affect common carp (*Cyprinus carpio* L.). *Marine and Freshwater Research*, 57(8): 817-823.