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A review on natural and artificial fish bait

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Abstract
Fish bait is essential for studies that aim to improve longline fishing, particularly through bait development. Availability of live baits during all seasons and even the cost factor hinder the fishing quite often. As an alternative, development of "artificial dry bait" is gaining importance in recent years. In this connection. This review provides an overview of our understanding of different types of fish baits such as natural and artificial baits. Physical properties such as size, shape, texture and strength can also be manipulated in a manufactured bait to improve catch efficiency.

Keywords: Natural bait – Artificial fish bait – Fish waste – Fishing methods –Trap fishing

1. Introduction
Trap fishing is one of the important fishing technique around the world, in which, bait plays a key role and decides the success (Lokkeborg *et al.*, 1990) [23]. Forage fishes such as mackeral, herring, sardine, squids and anchovies are generally used as natural baits in traps and long lines. However, these fishes have good market demand as human food owing to their nutritional value. Because of the increased market demand, both for human food as well as for bait, the prices of these fishes have increased dramatically in the past decade. Hence in recent years, there have been efforts to produce artificial baits, which can substitute or rather more effective than natural fish baits for catching fish and other aquatic animals. Artificial lures resembling insects, small fishes, shrimps and other natural prey of fish species are widely used to catch certain fishes by visual stimulation around the world (Bjordal and Lokkeborg, 1996) [5]. However, such lures otherwise called jigs have potential use in capturing active predators in trolling lines. In general, traps and stationary hook and line fishing gears require baits that resemble natural baits with adequate attractants being released in a sustained manner till the capture of the fish. Attractants meant for the preparation of artificial fish baits should be cheap and at the same time, available year round and in large scale. Artificial bait manufacturing factories can evolve in collaboration with fish processing and poultry processing plants on the development of artificial fish baits based on these processing wastes. United Nation Organization (UNO) has stressed the need for developing synthetic fish baits with the view to conserve forage fishes, which are used globally to the tune of 18 million metric tons in hook and line fishing alone accounting for about 40*%* of their annual catch (UNO, 2014) [33]**.** So this present study discussed about different types of natural and artificial bait in trap fishing.

2. Natural Bait
2.1. Usage of natural bait in trap fishing
Johnstone and Hawkins (1981) [16] tested the effectiveness of different natural baits such as mussel, mackerel, squid and salted herring for the capture of cod. Among the various baits tested, saithe mussel was found to be the most attractive natural bait. Daniel and Bayer (1989) [11] reported that the attractants present in the dried fish homogenate of herring performed well in the commercial fishing of the American lobster, *Homarus americanus.* Bait prepared with sugarcane and fish was found to be more effective for the capture of crabs in traps (Kawamura *et al.*, 1995) [20] and Lokkerberg (1990) [23] reported that the behavior of cod (*Gadus morhua*) towards two different shaped natural baits made from minced meat of *Scomber scobrus* one was in rectangular shape other fish shaped bait. The baiting behaviors was observed in the sea with the help of underwater television. Though Cod did not show any significant difference in the responses towards the two types bait, large sized cods showed more intense response towards the baits than that of smaller cods.

Huner *et al.* (1990) [15] studied the catching efficiency of bait fishes such as skipjack herring. Gizzard shad, common carp and channel cat fish heads along with formulated baits for Capturing cambarid crawfishes in traps. Common carp was found to be the most effective natural bait and the formulated baits performance was on par with the performance of natural baits such as Skipjack herring and gizzard shad. Furevik and Lokkeborg (2014) [25] have reported the catching efficiency of three different types of baits such as, squids, herring and crabs for the capture of torsk *(Brosme brosme)* and cod *(Gadus morhua)* in the experiments conducted off the coast of Norway. Squid and crab baits performed better than herring bait in capturing cod.

Dale *et al.* (2007) [10] reported that the trap baited with Blue mussels (*Mytilus edulis*) and roe of cod (*Gadus morhua*) showed significantly higher CPUE compared to traps baited with natural baits. Chang *et al.* (2008) [8] used four kinds of baits such as (i) grinded krill with gluten, (ii) grinded mackerel, (iii) grinded intestine of mackerel, and (iv) grinded tuna intestine with grinded mackerel. Among the four baits, the tuna intestine with grinded mackerel was found to be more effective. Westerberg and Westerberg (2011) [34] analyzed the properties of odour plumes of natural baits under different environmental conditions.

2.2. Different types of artificial fish bait development for trap fishing

2.2.1. Fish waste based artificial fish baits

Carr (1981) [6] developed a wet artificial fish bait comprising of a water insoluble matrix made from gelatin. Glycerin was used as humectant to maintain desirable moisture level. Liquefied fish, fish oils, and anise were used as attractants. Diffusion at a predetermined and controlled rate over a prolonged period of time was achieved upon immersion in an aqueous medium. Ong (1985) [28] prepared a cheese based fish bait with stiff consistency suitable to mold over a fish hook under moving water condition. Stephen and Stephen. (1975) [32] developed artificial baits suitable for long line fishing and crustacean trap fishing. The baits consisted of 2 to 50% water insoluble polymer 45 to 98% plant derived particulate attractants and 0 to 20% edible oil/molasses.

Lokkeborg, (1990) [23] analyzed the releasing pattern of potential feeding attractants both from natural and artificial baits in following seawater condition. The study revealed that the releasing rates were initially high within the first 1.5 hrs of exposure and there after it decreased. His finding proved that the artificial bait was comparable with natural baits with regard to releasing rate of bait attractants. Lokkeborg (1991) [24] developed an artificial long line bait using minced meat of herring either with Guar gum or Gelatin and packed in nylon bag for the capture Torsk (*Prosme brosme*), Haddock (*Melanogrammus aeglefinus*) Cod (*Gadus morhua*) and Ling (*Molva molva*). Channes and Viana (2000) [7] reported that fish silage based artificial bait suitable for trap fishing for catching lobsters. Further, that silage based dry baits could attract lobsters similar to wet baits.

Archadale *et al.* (2008) [2] compared catches of swimming crabs using fish mince in tea bags and conventional fish baits. *Scomber japonicus* was either minced and packed in a teabag or cut in half and used as bait. The crab catches of *Charybdis japonica* and *Portunus pelagicus* from traps baited with fish and minced fish packed in tea bag were not significantly different, however, differences could be noticed in total catch and the catch of the damselfish, *Chromis notata*. Trials using 80 g of mince and 20 g of sugar in the teabag bait lowered the catch of *Charybdis japonica*, *Thalami tasima* and *Thalami taprymna* but not *P. pelagicus* was compared to that of fish bait. Results indicated that the fish mince kept in teabags as suitable as fish bait, and that adding substances to the mince could pave way for selective capture of crabs. Archdale and Kawamura (2011) [3] compared the luring effectiveness of artificial bait made from fish waste with natural baits in pots targeting the sand crab *(Ovalipes punctatus*) in the East China Sea**.** The type of baits were mackerel, minced heads of greenling and two artificial baits made mostly from fish waste and starch. The first two baits required frozen storage while the rest of the two artificial baits not require any frozen storage as they dried type. Fish was significantly more attractive than minced bait and artificial baits, Natural baits disappeared almost entirely by the time of hauling, with only 1% of the fish and 5.3% of the minced bait remaining; artificial bait remained almost intact (96.3–100%). However, artificial bait catch was approximately half of that of fish bait. Anderson (2014) [1] developed an alternate bait for the capture of Louisiana commercial blue crab (*Callinectes sapidus).* He used attractant derived from fish processing waste for bait development.

Siikavuopio *et al.* (2017) [31] reported that the hydrolysates derived from shrimp and mussel wastes could be the better substitutes for the capture of cod. Atlantic cod (*Gadus morhua*) in fish traps owing to their superior attracting ability. Three commercially available protein hydrolysates made from shrimp (*Pandalus borealis*). Blue mussels (*Mytilus edulis)* and capelin (*Mallotus villosus*) were used to study the baiting behavior of the Atlantic cod. The Results showed that hydrolysate from shrimps and blue mussel were found to be have better potential to replace natural bait traditionally used to captured.

2.2.2. Chemicals based synthetic artificial bait

Stephan and Stephan (1975) [32] developed a fish bait with water-soluble proteinaceous gel in the interior part and insoluble skin like in the exterior part. The interior part was formed by mixing a gel-forming proteinaceous material and water at a temperature above the solgel transition temperature, which facilitated the alteration of proteinaceous material to the structure of desired shape. Fish egg wastes and cannery wastes were utilized as part or whole of the proteinaceous material so as to provide the characteristic odour associated with salmon eggs. To alter the gel characteristics, humectants were added. Cooling the shaped interior mass and treating its exterior surface with a tanning agent such as formaldehyde yielded the complete bait. Wolford *et al.* (1988) [35] evolved an artificial fish bait suitable for sport fishing with hook and line, commercial longline fishing and lobster trapping. They used a water-soluble cellulose ether and a plasticizer namely polyvinyl alcohol as sustained releasing agents.

Prochnow (1992) [29] developed a fish bait of dough or putty-like consistency which could be attached over the hooks. The bait comprised of Cellulose Ether and a Poly alkylene glycol (Polyethylene Glycol) blended with water to form slimy surface. The bait was made moldable as well as water soluble besides to have controlled rate of dispersion. Guthrie *et al.* (1993) [13] prepared a degradable fish bait using degradable substances such as polyurethane Polymer and Gel polymer foam with hydrolytically unstable ester linkages along with various other additives. The bait was made in such a way that some of the additives are released from the bait at sustained

rate. Sensory stimulants were added with the view to attract the fishes. Cook and Mimi (1993) [9] used Sodium alginate and Carrageenan to develop and artificial bait suitable for fishing both fin fish and shellfishes. Ground fish head, fish viscera, fish tail, dried fish meal, natural amino acids and organic acids were used as attractant. Disodium phosphate was used to increase the gel strength. Sucrose, Fructose, Sorbitol and Dextrose were found to decrease water activity of the bait. A long-chain poly hydroxy polymer, a water-soluble polymeric gum and a hydrogen-bonding accelerator were also used in the preparation of bait. The lures were cured after molding by subjecting it to the freezing temperature.

Ollis (2004) [27] developed a biodegradable fishing lure using animal gelatin as the base material and Glycerol, sucrose, Carrageenan, Sodium alginate as cross linkers. The amino acid 'Betaine' was found to be a feeding stimulant in several prey fish species, including some species of flat fishes, salmonids and sturgeons (Yamashita *et al.*, 2006) [36]. Low molecular weight substances such as amino acids, peptides, prostaglandins, bile acids and steroids have been identified as fish feed attractants as well as stimulants. Amino acids comprise most important group among them and they may act either singly or in combination to play a major role in stimulating the feeding in fishes. The amino acids such as Alanine, Cysteine, Serine, Glutamine, Glycine and Proline seem to act as feeding stimulants (Raubenhaimer *et al.*, 2010) [30].

Studies have been attempted to identify the chemical nature of feed attractants and stimulants (Kasumyan and Doving, 2003 [19] and Hara, 2011 [14]). A synthetic bait has been developed to capture crustaceans by Dellinger *et al.* (2016) [12] to obviate the need for forage fish capture and their depletion due to utility as bait in traps. The bait was designed in such a way that it as if trembled attractants molecules are released from forage fish at a controlled rate. The bait consisted of a soluble matrix and form which the attractant was allowed to release at a controlled rate. The synthetic bait could capture stone crab, blue crab, and the American lobster in field trials.

3. Present status of bait utility in trap fishing

S Balasubramaniyan (1964) [4] reported the use of live Prawns, Sardines, Anchovies, Ribbon-fish, silver bar fish, Trigger, Lizard fish, Trigger-fish, Bombay-duck, Squids, *Clupea longiceps, C. brachysoma, C.fimbriate, Engraulis purava, E.malabaricus, Dussumieria hasseltii, Chirocentrus dorab,Scomber microlepidotus, Stromateus spp, Caranx kalla, Equula spp, Mugil cephalus,Plotosus canius, and Saurida tumbil* as baits in fishing. He has also reported that non-availability of the right type of bait at the time of their need and procurement of live baits and keeping them alive till their use are the major constrains in using live baits for line fishing. The utility of shrimp head wastes as natural bait in fish traps along the south-east coast of India have been reported by few researchers (Kalaiyarasan *et al.*, 2012 [17]; Karthy *et al.*, 2014 [18]; Mariappan *et al.*,2016 [26]).

Kumar *et al.* (2015) [21] reported, the catching efficiency of three bait species, *viz*., Indian mackerel (*Rastrelliger kanagurta*), Indian oil sardine (*Sardinella longiceps*) and smooth belly sardinella (*Amblygaster clupeoides*) and its loss rates were changed in bait species has no significant effect on the overall hooking rate in the longline operations, though variation was observed in catch composition. Depth of operation has no significant effect on the bait loss, within the range of 100 m depth. However, the bait loss was observed to increase with soaking time. Scavenging by the small fishes was frequently observed during the study which may increase the rate of drop off of the bait from the hooks**.**

Kumar *et al.* (2016) [22] in his review on status of long line fishing India reported that, fishermen depend exclusively on the wild caught fishes for baits. Many of the species used as baits were found to be edible fishes of human food standard. Harvesting of these fishes to use as baits in longlines lead to additional fishing pressure on such species. Hence, artificial bait preparation for long line fishing in the need of the hour no studies have been carried out in India on the development of artificial fish bait suitable for long line fishing.

4. Conclusion

This review has shown that there exists a large quantity of important knowledge about different types of fish baits and uses. Also this review has revealed that few studies have been aimed at developing new bait types to replace traditional longline baits. Moreover, the studies that do exist provide litte information about the composition and preparation of the bait tested.

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