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Evolving artificial fish bait using shrimp processing and poultry wastes

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Abstract
This study is focused on the use of dry artificial fish bait such as shrimp head waste (SHW) and poultry intestinal muscles (PIM) for trapping fish instead of if using costly edible fishes such as sardines (*Sardinella gibbosa*) and squids (*Uroteuthis duvaucelii*) as baits. About 25 dry baits were prepared and tested for stability in seawater and acceptance by tilapia (*Oreochromis mosambicus*). Based on the results, two baits were selected for the experiment. Selected baits were differentiated into two shapes (stick and sphere) and tested for protein leaching and dry matter loss in sea water. The stick-shaped bait considered as a more appropriate because it containing 52% PIM and 20% SHW with the protein leaching rate of 11.71 mg/g/h and dry matter loss of 40.12 mg/gm/h. When these stick shaped baits used for fishing, the catch rate was significantly higher ($P<0.05$) than those baited with squid meat (18Nos/trap) and sardines (22Nos/trap). Further, the catch rate of traps baited with artificial bait (36 /trap) was compared with those baited with raw shrimp head wastes (37Nos/trap).

Keywords: Artificial fish bait, catch efficiency, protein leaching, poultry waste, shrimp head wastes, waste utilization

1. Introduction

In recent years, the meat industry is one of the largest producers of organic waste in the food processing sector which can be either from shrimp or poultry industry. The recycling of this wastes can be achieved either by extracting useful components or it can be incorporated into formulation desirable seafood products. A better economic use of these offals would minimize the pollution problem and the same time maximize the profit of the processor which in turn help to the consumers. A notable increase in the generation of industrial wastes both through shrimp processing industries as well as from domestic poultry markets is witnessed in India. These wastes are either transformed as fish meal or sold as manure at a cheaper cost. Their unplanned disposal also leads to environmental pollution and hence their proper utility should be ensured.

Every year 6-8 million tons of shell wastes are produced globally, which accounts for about 33% of shrimps weight and it is completely discarded even though it contains about 46.5% protein, 28% chitin, 10.5% lipids and 15% ash [7]. However, the contribution of India to the global shell waste is considerably more because the total Indian shrimp production has been estimated as 4,34,557 tons during the year [22]. Even though, SHW has been used as an ingredient in fish feed and baits in fish traps, storage of such baits without losing it quality is a main hurdle to the above process. Similarly, waste products from poultry processing must be efficiently dealt which as the total annual population of poultry during the year 2013-14 has been estimated as 729.21 million numbers, [6] in which India is bestowed with vast livestock wealth and contribution is poultry meat production during the year 2013-14 is 1.916 million tones[6]. Increased production utility at that of SHW. Although poultry waste is mainly used as a fertilizer, it has been shown to be a potential source of nitrogen and other essential nutrients. Which paved a way for a generation of ruminant feed[17], extraction of methane gas From poultry slaughterhouse, preparation of sportgats, meat meal, poultry grease hormones and enzymes from poultry intestines [15]. Preparation of dried poultry manure from poultry offal [23, 25] producing prebiotic supplements.

Bait is an important factor that decides both quality and quantity of fish to be caught in the trap [2]. Fishes prefer to use fresh or frozen fish as bait. Even though they devote a considerable amount of money, energy and time to secure, maintain and handling of this bait [4].

According to the suitability crustaceans baits have more CPUE as compared to the natural fish baits [10]. In view of that hydrolysate derived from attracting ability [24]. Furthermore, certain studies were reported that utilization of certain fish byproducts such as fish silage based artificial baits and minced fish meats are the ideal baits for trap fishing and the farmer one is more suitable for lobster fishing [3, 8, 21]. Hence in the present study attention was given to select appropriate attractant and binders for the artificial dry fish bait.

2. Material and Methods

2.1 Experimental design

In the present study, tapioca flour (TF) which is commonly used in fish feed preparation and seed powder of Kadukkai powder (KP) *(Terminelia chebula)* which is used as an important herbal medicine for human being [13, 26] and has been used as binder in ancient civil constructions [11] were *used as binders for the preparation of artificial dry baits. T*he baits were tested for stability in seawater and acceptability using fingerlings of tilapia, *O. mosambicus in vitro.* Two baits were screened out as ideal baits based on the water stability and bait acceptability out of 25. They were prepared in two forms such as stick and sphere. The stick bait had the length of 60 ± 3 mm and the diameter of 6 mm, while the spherical bait had the diameter of 17 ± 2 mm. The most ideal bait was identified by conducting protein leaching test and dry matter loss in sea water.

2.2 Preparation of experimental baits

The 25 experimental baits were prepared with the PIM, SHW and binders such as TF and KP. To standardize the level of PIM, SHW, TF and KP, five baits were prepared by adding PIM *at* different levels,40-80%, six baits were prepared by adding varying the levels of SHW at 0-25%; seven baits were prepared by adding TF at different levels, 0-30%; and seven experimental baits were prepared with seven different levels of KP, 0-12%. The compositions of various ingredients used to prepare the baits are given Table 1.

The resultant dough was boiled in a pressure cooker for 15 min. After cooling at room temperature, the dough was extruded through a die of 6 mm diameter using a hand extruder.

2.3 Analysis of bait stability in seawater

An aquarium tank with the dimension of 53 cm × 20 cm × 15 cm (L/B/H, respectively) and made up of 7 mm thick glass panels were used for the study. In each chamber, 1.5 L of seawater was filled. Five baits were tested simultaneously by dropping 20 g of test bait in each chamber. The disintegration and dissolution characteristics were analyzed at an interval 1-24 h. Based on the duration of stability in hours the baits were categorized into five types (i) very much stable (15-24 h), (ii) highly stable (12−15 h), (iii) moderately stable (8−12 h), (iv) less stable (5−8h) and (v) very less stable (0-5 h). As the soaking duration of the trap in commercial fishing operation was 12h per baits, which were stable up to 12h and above the level were considered as ideal baits and those which had stability less than 12 h were considered as non-ideal baits.

2.4 Bait acceptability test

An aquarium tank with the dimension of 87 cm× 34 cm× 29 cm*(*L/B/H, respectively*)*made up of 15 mm thick glass panels was used for this study. About 15 fingerlings of tilapia (*O. mosambicus*) with the mean length of 90 ± 5 mm *SD* were released in the "stocking section" of the tank and the test bait was introduced in the "bait testing section". After 10 min, the glass partition was removed. The approach of tilapia fingerlings towards different baits were observed and scores were given based on six different behavioral patterns as prescribed by Ghisalberti [12] (Table 2). Mean and standard deviation of the scores were used to classify the response level of the bait as low, medium and high as follows;

High= Scores above the Mean+SD
Low = Scores below the Mean-SD
Medium = Scores in the range of Mean ±SD

2.5 Protein leaching analysis

Ten grams of the test bait was dropped into 100 ml of seawater taken in a 250 ml beaker. Six beakers were used to test six baits simultaneously. The beakers were given a constant shaking using a refrigerated horizontal shaker maintained at a temperature of 25 ˚C and the operational speed of 75 ± 5 rpm [8]. One ml of the liquid sample was taken at 0^{th}, 2^{nd}, 4^{th}, 6^{th}, 8^{th}, 10^{th} and 12^{th} h of bait immersion and analyzed for protein content following the method of Kjeldhal [5].

2.6 Analysis of dry matter loss

The remaining baits from the beakers were used for protein leaching analysis and for dry matter loss study. The remaining baits were collected at 0^{th}, 2^{nd}, 4^{th}, 6^{th}, 8^{th}, 10^{th} and 12^{th} h of immersion for the analysis of dry matter loss. They were taken in Petri dishes and dried in a hot air oven at 110˚C for 24 h. The dry matter loss of the bait was expressed in percentage [8].

2.7 Analysis of proximate composition and water activity

Moisture, Protein, Fat content, total ash content were determined as per 5 *methods.* Apart from proximate composition, the water activity was determined using a Water activity meter (Aqua lab LITE, Pullman WA 99163)

2.8 Fishing experiment

The newly selected bait was tested for its catching efficiency in comparison with shrimp head waste, sardine and squid meat. The baits were tested in the commercial fish traps of Rameswaram (9°12'44.7"N, 79°05'48.9"E) (Fig 1). Five traps were used for testing each bait and 80 g of the bait sample was used for testing the efficiency by hanging it from a bait bag, which was allowed to hang inside the trap. The traps were set at 4 pm and taken back on next day at 4 pm at the interval of 12 h of soaking duration. After hauling the traps, caught fishes were separated species wise and segregated fishes weighed to the nearest gram using a top pan balance. The length was measured using a scale nearest to the millimeter. The fishes caught were identified by FAO Species Catalogue [14].

3. Results and discussion

3.1 Bait stability

25 baits prepared were tested in seawater to check their stability. They reality differ in their stability. 13 baits shows their stability up to 12 hrs and above (Table 3) in seawater. Four baits among 25 namely 1, 2, 24, 25 due to their high content of TF ranging from 42 to 50% shows very high stability. Years back few researchers in their research on shrimp feed had came to the same conclusion. Ali [1] observed the increased stability of shrimp feed with a content of TF ranging from 9% to 37%. Later in the year 2005, he combined

TF with guar gum in his experiment and was succeeded. In the above combination, TF has improved its binding capacity. Another group of 9 baits within 25 tested (3, 8, 9, 10, 11, 17, 18, 22 and 23) showed high stability due to a high level of TF ranging from 19 to 34%. Regarding KP, Emayan and Rahuman[11] in the year 2015 found that when KP was incorporated at 10% level it showed an increased compression strength of 2.04N/mm^2 in the lime mortar admixtures. Similarly in the present study, with an increased addition of KP ranging from 3 to 12% leads to an increased binding strength had been observed. However some baits namely (1, 2, 3, 8, 9, 10, 13, 14, 15, 16, 22 and 23) with 5% to 12%. KP when soaked in seawater for 2hrs, the water became turbid. So these baits results in medium acceptability. Bait 4 baits among the 25 (4, 6, 7, 16) shows the moderate level of stability, which may be due to TF of a level below 255 and that of KP below 4% (Table 3).

Nine baits shows moderate stability due to the addition of SHW which contains chitin that is a non-adhesion ingredient with other water soluble ingredients of the bait. Coward-Kelly *et al* [9] have reported the total crude protein and chitin content in SHW as 64.1% and Kumar [18] has observed the content of chitin is 5 to 20% in SHW. The low level of KP ranging from 1% to 2% in some baits (5,15,20 and 21) were found to be less stable. Another group of bait (12, 13, 14, 19) shows a lesser stability ie; not more than one hour. This may be due to the lower content of TF ranging from 0 to 10% and that of KP ranging from 0% to 3% (Table 1 and 3). Coward-Kelley *et al* [9] have reported the total crude protein and chitin content in SHW as 64.1% and Kumar [18] has observed the contribution of chitin as much as 15 to 20% in SHW. The reason for the moderate stability of nine baits may be attributed to the addition of SHW which contains chitin that is a non-adhesive ingredient with other water soluble ingredients of the bait. The bait 5,15,20 and 21 were found to be less stable which may attribute to low level of KP ranging from 1% to 2%. Further, the bait 12,13,14 and 19 showed the lowest stability of less than one hour which may be attributed to the very low level of TF ranging from 0 to 10% and low level of KP ranging from 0 to 3% (Table 1&3).

3.2 Bait acceptability

Amino acids have been identified as food attractants and adding the right amino acids which make a value addition to every bound of bait. It increases the palatability and acceptability of feed differing and also several researchers demonstrated the attractiveness of amino acids in the bait [16, 19, 20]. According to the acceptability the 25 baits can be classified as three such as. baits which show a high level of acceptability (Nos 5, 12, 13, 19 and 20). medium level acceptability (Nos 3, 4, 6, 7, 8, 9, 14, 15, 16, 17, 21, 22, 23,and 24) and low level of acceptability of live baits is mainly due to the addition of high level of PIM ranging from 55 to 80% (Table 1 and 4), when the percentage of PIM is reduced (49-60%) and the addition of KP (4-10%) decrease the acceptability of baits Nos (medium baits). Obviously, 6 baits were found to show low acceptability. Due to high level of KP ranging from10-12% and low level of PIM ranging from 43 to 49% (Table 2 and 4). Hence, the acceptability of the bait is affected. it is evident through the stability analysis (Table 3) and bait acceptability tests (Table 4) that the bait 22 and 23 are ideal baits for fishing.It is evident through the stability analysis (Table 3) and bait acceptability tests (Table 4) that the bait 22 and the bait 23 may be considered as ideal baits.

3.3 Protein leaching and dry matter loss

The study revealed the clear differences of fish bait and shrimp feed with respect to protein leaching rate and the suitable bait for trap was chosen. Ali *et al* [1] observed 4–6 h of stability as essential criteria for shrimp feed. However, in the present investigation, stability up to 12 h was found to be very effective for fish baits to ensure their availability in the trap at least for half of the soaking duration of traps (i.e. 24 h) so as to ensure sustained attraction of fishes into the trap. Although the fish feeding is a time restricted activity, bait attraction needs to be a sustained activity till the traps are taken back after soaking. While the rate of the protein leaching decides the propagation of attractant around the trap, the dry matter loss decides the extent of availability of bait in the trap during operation. Chanes-Miranda and Viana [8] observed protein leaching rate and dry matter loss of 11.4 ± 0.46 mg/g/h and 26.03 ± 0.04 mg/g/h, respectively. However, in the present study, the protein leaching rate of the bait 22(a) and 23(a) were relatively low (11.71 mg/g/h and 10.227 mg/g/h, respectively) under similar conditions, (Table 5). This may be attributed to the higher protein content of the bait 22 and 23 (Fig. 1).

Lokkeberg [19] reported that the binder used in artificial bait must have chemical properties that give a certain release rate of attractants over most of the soak time. In the present investigation, the bait 22(b) and 23(b) was found to have 70% and 79% of the protein even after 12 h of soaking (Table 5), which reveal the fact that it has attracting ability even after 12 h of soaking due to the synergistic binding effect of TF and KP. So, this bait is not suitable for trap fishing because of its more protein holding the bait. Bait 22(a) have 62% of the protein even after 12 h of soaking (Table 5) and it was more suitable for fishing.

The shape of the bait was found to have notable impact on the protein leaching and dry matter loss of the bait irrespective of the composition. The protein leaching rate and dry matter loss were invariably high for stick shaped baits (22a and 23a) than spherical shaped baits (22b and 23b) (Fig. 1). In the present study, among the two baits 22(a) and 22(b), high level of protein leaching and dry matter loss was observed in 22(a) stacking from the time of soaking till the retrieval of traps (Figs. 2 and3). Further, incorporation of KP at 3% level in the bait 22(a) (Table 1) was found to be responsible for the increased protein leaching rate and dry matter loss of 11.713mg/g/h and 40.125.6mg/g/h, respectively (Table 5). Further, it had stability on par with the bait 23(a) up to 13 h (Table 3) due to the addition of 4% KP (Table 1). Dry matter loss showed positive correlation with protein leaching in the respective baits tested (r = 0.98 (22a), r = 0.99 (22b), r = 0.99 (23a), r = 0.97 (23b)) (Figs. 1 and 2). Hence, the study implies that SHW is required in the bait at the level of 20% to increase the protein leaching rate while the addition of KP is required up to 3% to ensure stability and dry matter loss for about 12 h. In the present study, the bait 22(a) was found to be the most ideal bait because it adequate duration of stability in seawater (12 h) (Table 3), higher acceptability score (28/30) (Table 4) and higher protein leaching rate (11.713 mg/g/h) (Table 5).

3.4 Catch efficiency

A total of 10 species caught in the traps baited with artificial bait and natural baits were shown in Table 6. In the traps baited with PIM-based artificial bait, the highest mean catch rate of 36 /five soaking days/trap was observed. A similar observation has already been found by few researchers, dried artificial baits could be able to attract lobsters in a similar way to the moist baits [8 21]. Further, fishes were significantly more attractive to artificial baits [4, 21]. The catch rate of the traps baited with the artificial fish bait was significantly higher *(P*< 0.05*)* than that of baited with squid meat (18/five soaking days/trap) and sardines (22/five soaking days/trap). Further, the catch rate of traps baited with artificial bait (36/five soaking days/trap) was comparable with those baited with raw shrimp head wastes (37/five soaking days/trap) (Table 6). In the present study, it is proved that PIM and SHW with the combination can serve as an ideal attractant in the preparation of dry artificial baits.

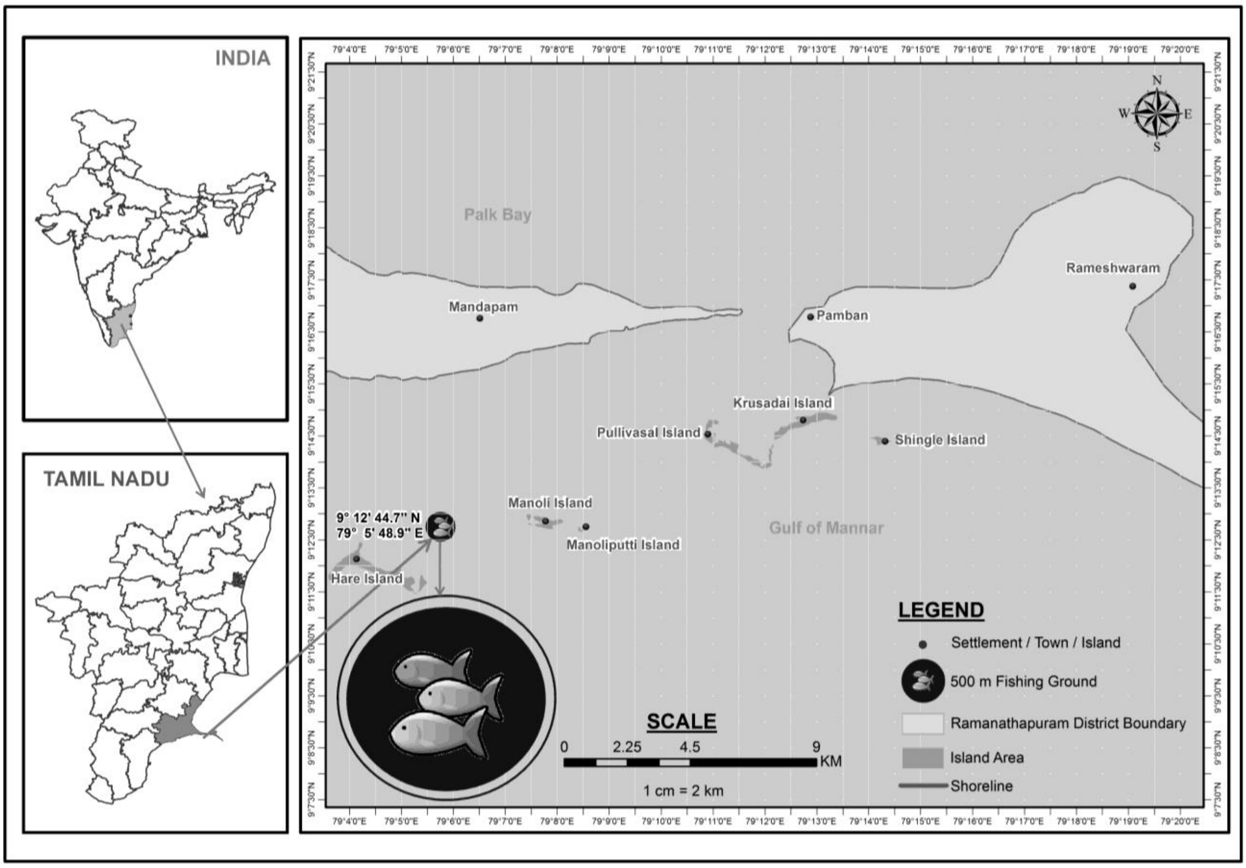

Fig 1: Location of fishing ground in Rameswaram coast, India

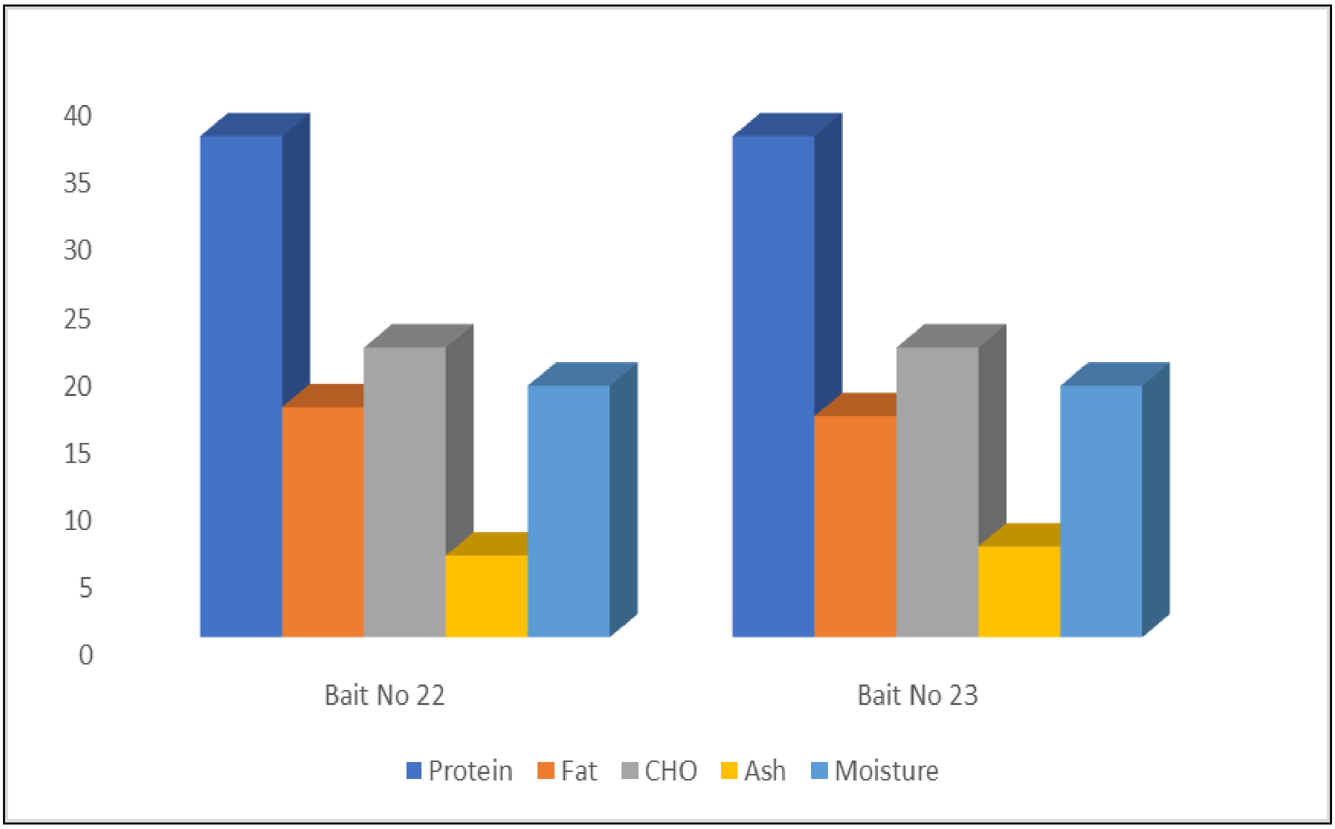

Fig 2: Proximate composition of selected experimental baits

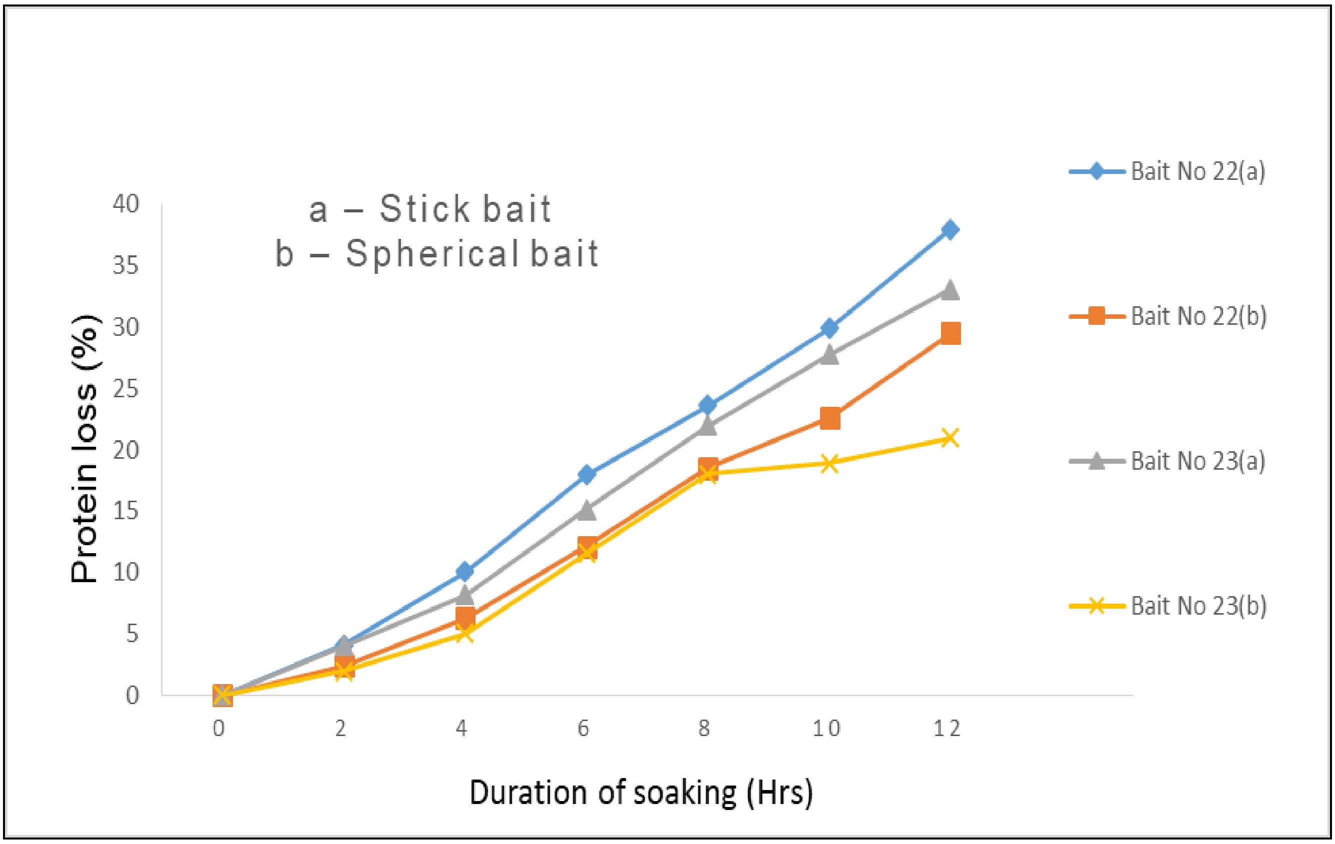

Fig 3: Protein leaching pattern of selected experimental baits in seawater

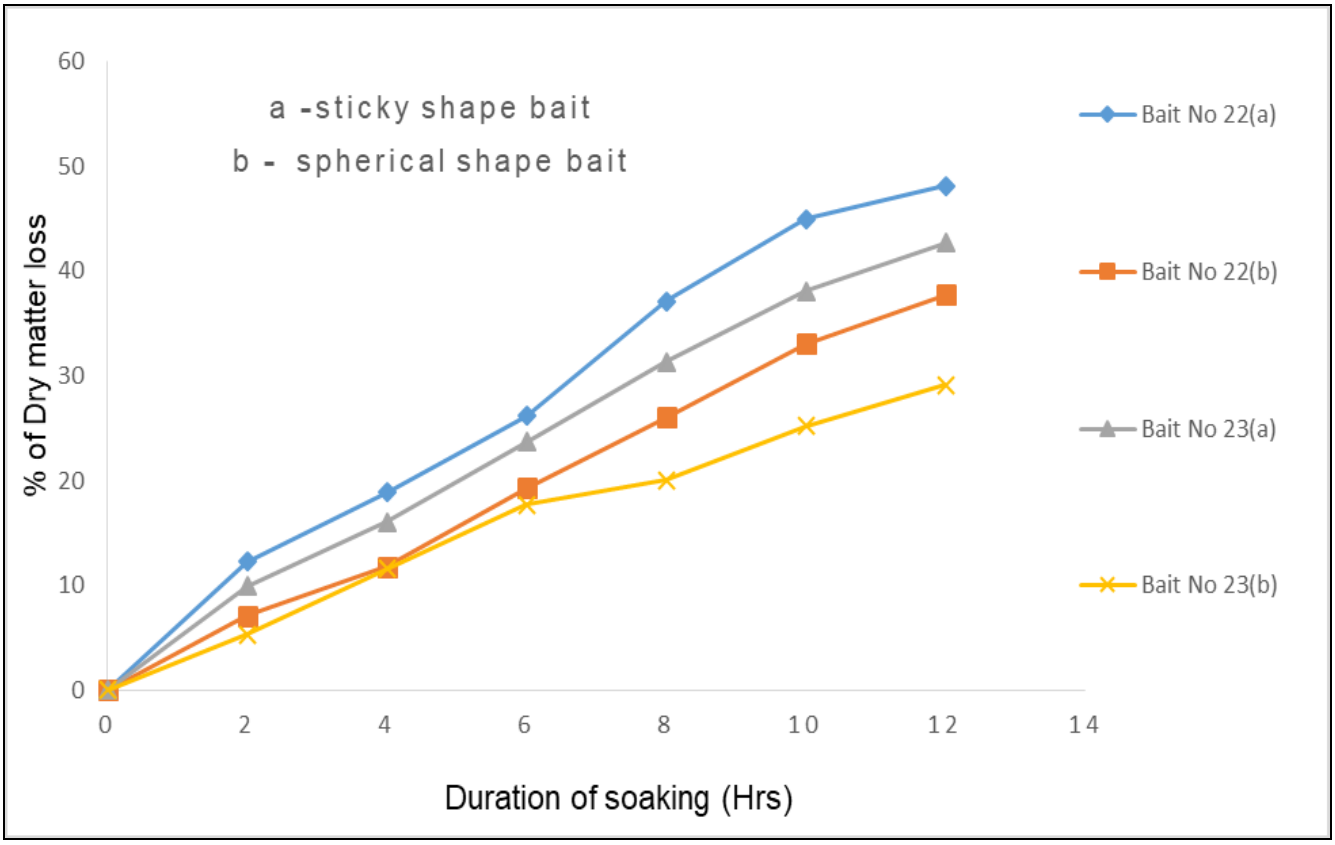

Fig 4: Dry matter loss of selected experimental baits in seawater

Table 1: The composition of bait ingredients in different experimental baits

Bait No	Attractants		Binders	
	PIM	SHW	TF	KP
Baits prepared for standardizing the level of PIM *(*values in weight percentage*)*				
1	40	0	50	10
2	50	0	42	8
3	60	0	34	6
4	70	0	16	4
5	80	0	18	2
Baits prepared for standardizing the level of SHW *(*values in weight percentage*)*				
6	74	0	24	2
7	68	5	23	4
8	62	10	22	6
9	56	15	21	8
10	50	20	20	10
11	45	25	19	12
Baits prepared for the standardizing the level of TF *(*values in weight percentage*)*				
12	79	20	0	1
13	73	20	5	2
14	67	20	10	3
15	61	20	15	4
16	55	20	20	5
17	49	20	25	6
18	43	20	30	7
Baits prepared for standardizing the level of KP *(*values in weight percentage*)*				
19	55	20	25	0
20	54	20	25	1
21	53	20	25	2
22	52	20	25	3
23	51	20	25	4
24	50	20	25	5
25	49	20	25	10

Note: PIM-Poultry Intestinal Muscles, SHW-Shrimp Head Wastes, TF-Tapioca Flour, KP-Kadukkai Powder

Table 2: Range of score values allotted for different behavioral responses of tilapia towards the test baits

Sl. No	Phases of fish behavior	Behavioral description	Score value
1	Detection	Change in position	1-2
2	Orientation	Change in position; Turning towards the bait	1-4
3	Locomotion	Decisive movement towards the bait	1-6
4	Continuation	Ingestion baits	1-8
5	Clustering		
(i)	Most attractive	Clustering within 1-2 minutes	10
(ii)	More attractive	Clustering after 2-3 minutes	5
(iii)	Less attractive	Clustering after 3-4 minutes	2.5
(iv)	Ignored	No response after reaching the bait	0

Table 3: Stability characteristics of artificial baits in seawater

Bait No	Duration of stability in hrs.	Observation	Inference	Remarks
1	17hr 15min	Very much stable however water become turbid and highly brownish	High level of TF	(+)
2	15hr 30min	Very much stable however water become turbid and highly brownish	High level of TF	(+)
3	13hr 05min	Highly stable however water become turbid and highly brownish	High level of TF	(+)
4	10hr 15min	Moderately stable	Balanced level of PIM& TF	(-)
5	8hr 50min	Less stable	High level of PIM and low level of TF	(-)
6	9hr 10min	Moderately stable	high level of PIM & TF	(-)
7	11hr 20min	Moderately stable	Balanced level of PIM & TF	(-)
8	12hr 10min	Highly stable however water become turbid and highly brownish	Balanced level of PIM & TF	(+)
9	12hr 40min	Highly stable however water become turbid and highly brownish	Balanced level of PIM & TF	(+)
10	13hr 10min	Highly stable however water become turbid and highly brownish	High level of KP	(+)
11	14hr	High stable	High level of KP	(+)
12	6hrs. 00min	Very Less stable	Absence of TF	(-)
13	7hrs. 00min	Very Less stable however water become	High level of PIM and Low level of TF	(-)

		turbid and highly brownish		
14	7hrs. 45min	Very Less stable however water become turbid and highly brownish	Balanced level of PIM and Low level TF	(-)
15	9hrs. 30min	Less stable however water become turbid and highly brownish	Balanced level of PIM and Low level TF	(-)
16	11hrs. 00min	Moderately stable however water become turbid and highly brownish	Balanced level of PIM and Low level TF	(-)
17	12hrs 25 min	Highly stable	Low level of PIM and optimum level TF	(+)
18	14hrs. 00min	Highly stable	Low level of PIM and high level TF	(+)
19	7hr 30min	Very Less stable	Absence of KP	(-)
20	8hrs. 10min	Moderately stable	Very low level of KP	(-)
21	10hrs. 00min	Moderately stable	Very low level of KP	(-)
22	12hrs. 10min	Highly stable	Optimum level of KP	(+)
23	12hrs. 20min	Highly stable	Optimum level of KP and other ingredients	(+)
24	13hrs.00min	Very much stable, however water become turbid and less brownish	Very high level of KP	(+)
25	18hrs. 45min	Very much stable, however water become turbid and highly brownish	Very high level of KP	(+)
Note: PIM – Poultry Intestinal Muscles; SHW – Shrimp Head Waste; TF – Tapioca Flour; KP – Kadukkai Powder; (+) Stable for 12 hrs and above, (-) Not stable up to 12 hrs				

Table 4: Acceptability scores of artificial baits

Bait no	Phases of behavior ⁄Scores					Total score	Remarks
	Detection	Orientation	Locomotion	Baiting	Clustering		
1	2	3	5	5	2.5	17.5	L
2	2	3	5	5	2.5	17.5	L
3	2	4	5	5	5	20	M
4	2	4	6	6	10	28	M
5	2	4	6	7	10	29	H
6	2	4	6	6	10	28	M
7	2	4	6	6	10	28	M
8	2	3	5	5	5	20	M
9	2	3	5	5	5	20	M
10	2	3	4	4	5	18	L
11	2	3	4	4	2.5	15.5	L
12	2	4	6	7	10	29	H
13	2	4	6	7	10	29	H
14	2	4	6	6	10	28	M
15	2	4	6	6	10	28	M
16	2	3	5	5	10	25	M
17	2	3	5	5	5	20	M
18	2	3	5	4	2.5	16.5	L
19	2	4	6	7	10	29	H
20	2	4	6	7	10	29	H
21	2	4	6	6	10	28	M
22	2	4	6	6	10	28	M
23	2	4	6	6	10	28	M
24	2	3	5	5	5	20	M
25	2	3	5	5	2.5	17.5	L
Total						22.8±5.1	

Note: H=High, M=Medium, L=Low

Table 5: Protein leaching and dry matter loss of selected experimental baits in seawater

Bait No	Total protein content in bait (mg)	Total protein leached 12 hrs	Remaining protein after 12 hrs (%)	protein leaching rate (mg/g/hr)	Total weight of bait(mg)	Total dry matter loss(mg)	Remaining rate of dry matter after 12 hrs (%)	Dry matter loss rate (mg/g/hr)
22a	370.0	140.56(37.98)	229.44(62.0)	11.713	1,000	481.5	518.5	40.125
22b	370.0	109.15(29.5)	260.85(70.5)	9.095	1,000	377.2	622.8	31.433
23a	370.8	122.7(33.09)	248.07(66.9)	10.227	1,000	427.3	572.7	35.608
23b	370.8	77.86(20.99)	292.94(79.0)	6.488	1,000	291.0	709.0	24.250

Table 6: Catch particulars of traps baited with natural and artificial baits

Sl. No	Species	Shrimp head waste bait				Sardine bait				Squid meat bait				Artificial fish bait			
		ML	MW	Nos	TW	ML	MW	Nos	TW	ML	MW	Nos	TW	ML	MW	Nos	TW
1	*Cephalopholis formosa*	181.0	250	4	1000	175.0	220	2	440	96.50	130	2	160	98.00	130	1	130
2	*Cheilinus chlorourus*	195.4	190	4	760	193	265	2	530	194.0	202	3	604	190.0	194	4	776
3	*Lutjanus fulvus*	210.0	224	5	1120	190	220	1	220	290.0	400	2	800	222.4	238	4	952
4	*Lutjanus rivulatus*	210.0	215	3	645	178.5	190	3	570	180.8	210	1	210	266.0	312	2	624
5	*Scarus ghobban*	146.2	180	1	180	148	195	1	195	138.0	160	2	320	146.2	180	4	720
6	*Siganus canaliculatus*	220	200	5	1000	220.0	200	2	400	216.0	196	2	392	228.6	232	7	1624
7	*Siganus javus*	245.0	228	2	456	298	300	1	300	220.0	195	1	195	250.0	235	2	470
8	*Acanthurus* sp	295.5	235	3	705	175.0	160	3	480	195.0	185	2	270	276.0	200	3	600
9.	*Epinephelus* sp	188.0	214	4	856	137.5	145	2	290	124.0	125	2	250	160.0	175	4	700
10	*Lethirrinus* spp.	155.5	190	6	1140	176.0	218	5	1090	198.7	250	1	250	198.0	245	5	1225
	Total			37	7,862			22	4,515			18	3,451			36	7,821
Note: ML- Mean Length (mm), MW - Mean Weight (gm), TW - Total Weight (gm)																	

4. Conclusion

The study revealed that dry artificial bait with PIM and SHW considered being a better substitute to baits such as edible squids and sardines, as major attractants dry artificial bait could act as fish baits in traps, and also it maximizes the poultry and fish waste utilization, through which industrial pollution can be minimized.

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6. Disclosure statement

No potential conflict of interest was reported by the authors

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