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Alternative Processing Option from Shrimp Processing Biowaste in Khulna District-Southwestern Bangladesh

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Abstract: The study was conducted to assess the alternative processing option from shrimp processing biowaste for local people in Khulna district-southwestern Bangladesh. A survey was conducted to know the existing situation. From the survey it was observed that sharp increase in shrimp production did not lead the increase in product from biowaste due to the lack of technical method. The respondents also revealed the lack of financial support and political influence as constraint and the main promising facility was the raw material availability and dried product demand. The waste cause heavy environmental pollution as most often these are dumped into water body or open field. A significantly high biological oxygen demand ($p = 0.05$) was found in the Rupsha river, adjacent to about 16 processing plants. Therefore it could be concluded that a technical processing method could be introduced as a new arena to process waste with maximum drying rate for economic efficiency and microbiological quality. Also the minimum loss of essential components of the dried material and comparatively cheaper than any other mechanical dryer and do not require skilled labor to build with locally available material. However, more comprehensive study and pilot scale research should be carried out immediately to develop appropriate know how for success in this venture.

Key words: Alternative, option, shrimp biowaste, technical drying

INTRODUCTION

The waste is closely related to post harvest fishery losses. Shrimp waste consists mainly of shrimp heads and tail hulls. About 35% by weight shrimp raw material is discarded as waste. Value addition of shrimp waste could provide extra income for the low income people. Shrimp waste could be used as Fish or shrimp meal, poultry meal, dietary food, skin care and agricultural purpose. Shrimp waste is the principal raw materials for drying. In Bangladesh total waste estimated about 13677.98 mt. Total waste processed by sun drying in open place is about 3839.4 mt. also it was found that the traditional open sun drying method was practiced by about 1580 people with female involvement of 30%, with considerable number of young people (30-40 age groups) involvement in the waste processing. By nature, the waste is closely related to post harvest fishery losses. It is observed that, rapid expansion of fish and shrimp culture industry is created a serious environmental and hygiene problem (Chandrkrachang *et al*., 1991). Shrimps are normally sold headless and often peeled of the outer shell, thus the waste generated comprises mainly of the shrimps head, shell and tail. Shrimp waste could be processed in drying, fermentation etc. Shrimp waste could be processed as several human food such as pettis (shrimp paste), terasi, shrimp crackers (Superno and Poernomo, 1992), shrimp waste could also converted to shrimp loaves with 20% wheat flour and 30% fat emulsion (Suparno and Nurcahya, 1984). Chitin and chitosan is also value added product from shrimp waste (Superno and Poernomo, 1992). Shrimp raw material is discarded as waste is about 35-45% by weight, when processed is headless, shell on products. Peeling process which involves removal of shell from prawn, increase the total waste production up to 45% (Subashinghe, 1999). It also reported that about 80% original weight of raw materials is discarded from crustacean processing plants (Shahidi and Synowiecki, 1991). Shrimp waste in a dried form could be used as supplementation of fish meal, poultry and a natural source of carotenoids for pigmentation purposes (Shahidi *et al*., 1992); largely to impart desired flesh coloration to culture some marine fish such as salmon and trout. Shrimp meal also used in poultry diets. Shrimp meal is valuable in

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tropical fish and bird diets where properties or pigment enhancement are of greater importance (Meyers, 1986). Shrimp waste could be used as agricultural purpose such as fertilizer (Chandrkrachang *et al*., 1991). From the shrimp processing industries in the coastal region of Bangladesh about 1, 14,000 mt year^{-1} of shrimp waste is produced annually (Khan and Hossain, 1996). Waste quickly becomes colonized by spoilage organisms and is rapidly transformed into both a nuisance and public health hazard, which lead the poverty in the locality. Alarmingly high BOD values for water bodies nearby waste dumping sites indicating a major threat of aquatic pollution, which leads the water use conflicts (Bhuwapathapun, 1996). These wastes created a major problem to the processor as environmental restriction are enforced (Shahidi and Synowiecki, 1991). Considerable interest in innovation of technology for the utilization of shrimp waste could lead to several products of high economic value, supplementary protein source both for animal and human and to solve environmental pollution created by waste. This could reduce the socio- ecological conflicts and will upgrade the livelihood of the involved people.

Therefore, the objective of this research was to assess the alternative processing option from shrimp processing bio-waste in Khulna District- Southwestern Bangladesh.

MATERIALS AND METHODS

Data was collected from Khulna district i.e., Khulna (Khulna sadar, Rupsha, Khalishpur). Semi-structured and structured questionnaire has been conducted for interviews. Likert scale (Kothari, 1998) has been used to quantify the perception/attitude, interest of the waste users. In this method, the responses have been rated as 1 to 5 scales to help the respondents rank the items according to their choice. Secondary data collected from administrative and sectoral official, informal institutions and research institute.

Water quality measurement: The water quality was observed on the east bank of Rupsha River, where about 16 shrimp processing plants located. The samples were collected with the help of a boat in plastic bottle and closed properly to make sure that there was no bubble. Samples were collected about 1 meter below the surface. The water quality parameters have been followed the standard method and a number of sophisticated instruments were used. The water temperature, pH, Dissolved Oxygen (DO) was done immediately on the spot and then the sample were preserved by adding 4-5 drops HNO_3 (0.01N) to control the change of water sample, in addition the samples were brought to the laboratory for the further chemical analysis and kept it into a refrigerator. Other parameters like chloride, iron and biological Oxygen Demand (BOD) were measured within 72 h of collection, the instruments has been shown in Table 1.

Table 1: Methods used in water sample analysis

Parameter	Methods
Chloride (mg L^{-1})	Mohr's Argetrometric method
Iron (mg L^{-1})	EDTA titration method
BOD	Wrinkler's method (Anonymous, 1992)

Data analysis: The Statistical Package for Social Science (SPSS) and excel has been used for data processing and data analysis in this study. Weighted Average Index (WAI) has been used.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
0	0.25	0.5	0.75	1.00

RESULTS AND DISCUSSION

Distribution of shrimp processing plants: In Khulna district there are 34 shrimp processing plants established. The shrimp waste processing practice has been started from about 5 years from now by the local poor peoples, as a secondary job and the processors are almost in and around the area where the processing plants established. About 1580 total people involved in waste processing as traditional sun drying method, found in the study area and 70 waste processors were interviewed for the survey among them about 40 interview were selected from Rupsha, while Rupsha upazila alone shows about 46% of total processing plants, 23% of total waste processors are concentrated in this upazila. Rupsha is about 2 km distance and other plants are within Khulna.

Temrolling and relative humidity: Temperature changes are remarkable in Khulna District with the changes of seasons. The mean maximum temperature in Khulna was about 35.6°C recorded in the month of May. The mean minimum temperature was recorded in the month of January and it was 11.1°C (Table 2). Relative humidity is inversely proportional to the temperature. Higher the temperature lesser the relative humidity of the atmosphere. In Khulna, mean monthly relative humidity varies from 100% (June) to 57% (March). Temperature is the key point for drying in open sun.

Education: Rolling mill education level of the shrimp waste processors interviewed could be classified in to four categories. From the result it has been observed that, about 44% of the respondents were between primary

levels while 21% can only sign their name. After primary level only 28% could join in the secondary level while 7% could join in higher secondary level.

The education status express, 44% of the waste processors of the study area were between the primary levels of education while only 3% have access to higher secondary level (Table 3). This is may be due to the reason that, the concentration of schools is greater in the central areas of the district and did not have access for the rural peoples. This also observed by earlier study (Anonymous, 1999), though the number of school and college is fairly adequate in Khulna district, but their spatial distribution is not well balanced. This is alarming for any type of development of an area. People who are involved with shrimp waste processing method were poorly educated and thus they could not follow the method scientifically and couldn't understand how to do the practice more efficiently.

Age structure: The age structure of the respondent could be classified mainly three categories. About 60% of respondent belong to between 30-40 age group, this is most economically active labor force group in Khulna district (Table 4). This suggests that, a large number of young people are engaged with waste practice and if proper attention given, this practice could be done more effectively and scientifically.

Sex: About 70% male and 30% female are engaged with shrimp waste processing. Compared with other occupation female investment in shrimp waste processing is quite significant in the study area. This suggests that shrimp waste processing could be an impressive arena for female employment.

Occupation: The major occupation in the study area is agro centric (Anonymous, 2003). The result revealed about 53% was agricultural labor, while 20 percent was nonagricultural labor and 11, 10 and 6% were involved with employee, tricycle puller and construction labor respectively. In Khulna region, the *Penaeus monodon* (Bagda shrimp) is available through out the year because of year round *Gher* culture method, the peak season for the shrimp is July to September (Table 5).

Income from waste processing: The average annual income of the respondents revealed that they live below the poverty line (Anonymous, 1999). Income from waste processing constitutes total income on an average about 13%. This percent of income contribute insignificant to maintain their daily needs (Table 6)

Experience: The experience has been classified in to 4 categories. It was observed that about 40% of respondent has been experienced with 2 year as shrimp waste drying in the open place, while about 4% peoples were involved for 4 years (Table 7).

From the result it is observed that, the waste processors who were the more experienced, they got comparatively good dried products within their facilities and investment.

Total waste processing in a traditional sun drying method: A total of 1580 persons are involved in shrimp waste processor has been estimated in the Khulna district. However, all of the processors done traditional sun drying

Table 2: Monthly average temperature, rainfall and humidity (2003) in Khulna district (Anonymous, 2004)

		Temperature (°C)		Relative humidity (%)	
Months	Rainfall (mm)	Maximum	Minimum	Maximum	Minimum
January	0	23.9	11.1	99	74
February	0.04	29.5	16.8	95	67
March	155	31.1	19.5	93	57
April	63	35.1	25.5	95	63
May	125	35.6	26.0	95	65
June	251	32.9	26.2	100	73
July	287	32.5	26.5	99	78
August	255	32.6	27.0	99	76
September	137	32.9	26.2	97	84
October	315	32.3	25.0	100	78
November	0	30.5	19.4	89	76
December	22	26	15.2	98	77

Socio-economic status of waste processor community:

Table 3: Educational status of the processors interviewed (n = 70)

Education level	Percent	No. of respondent
Name sign	21	15
Primary	44	31
Secondary	31	22
Higher secondary	3	2

Table 4: Age structure of the respondent (n = 70)

Age	Percent	No. of respondent
10-20	0	0
20-30	20	14
30-40	60	42
40-50	20	14
50-60	0	0

Table 5: Primary occupation of the respondent (n = 70)

Occupation	Percent	No. of respondent
Tri.puller	10	7
Agri-labor	53	37
Non-agri-lab	20	14
Construction	6	4
Employee	11	8

Table 6: Income from shrimp waste drying in traditional method (n = 70)

Income from waste (%)	Income from others (%)
86	14

Table 7: Experience of shrimp waste drying in traditional method (n = 70)

Experience year^{-1}	Percent	No. of respondent
1	30	23
2	39	27
3	24	17
4	4	3

method. Total waste estimated from processing plants of Khulna region was about 13677.98 mt. Total waste processed by drying was about 3839.4 mt (Table 8).

Therefore, the result express that about 28% shrimp waste has been processed however from the unprocessed 72%, a portion has been dumped in to the river after processing and a portion has been utilized for other purpose such as:

- directly as human food by cooking of shrimp head
- directly used as food for cat fish culture system.

It has been suggested that percentage of processing is not satisfactory. Because of the shrimp waste are degradable in high temperature and humidity. In the current practice i.e. they were drying in the open public place therefore its difficult to get free access to that place as they required Supreno and Poernomo (Superno and Poernomo, 1992) have been also observed the limited utilization of waste because of the perishable nature of the waste.

Pollution

Water quality parameters: Measured water quality parameters are as follows: Biological oxygen Demand (BOD), Chemical Oxygen Demand (COD). Dissolved Oxygen (DO), Chloride (Cl), pH, Temperature and Iron (Fe). Collected parameters from Department of Environment (DOE), Khulna, have been plotted in the (Table 9).

Table 9 express, from last five years, almost all the parameters are within the range except the BOD in 2002 was 20 and it showed unusable for fisheries, processing and irrigation purpose while lowest was about 1 in the year 2004. However, the same parameters done by the researcher showed (Table 10) quite difference from the collected DOE parameters. According to DOE this may be due to the reason that the DOE did the analysis during the day from 10.00 h to 14.00 h but the processing in shrimp industries mostly done in night. As a result the all parameters are somewhat changed or distributed in the next morning by the tidal effect. Though it has been reported that about 12.53 mt of BOD is produced annually in this river (Anonymous, 1997). In addition, Table 10 revealed that, about 122 mg^{-1} BOD has been detected around 200 meter distance of fish processing plants, showed a negative correlation with DO. The amount of chloride is moderately high, which indicates a fairly high and alarming for the water environment. This might be mainly due to the reason that the shrimp processing plants discharges a considerable quantity of waste richer water and they use chlorine as disinfectant in water. This

Table 8: Shrimp waste processing from total waste

Total waste (mt $year^{-1}$)	Waste dry (mt $year^{-1}$)	Percent	Others (mt $year^{-1}$)	Percent
13677.98	3839.4	28	9839	72

Table 9: Water quality parameters adjacent to plant area to Rupsha River, DOE, Khulna 2004.

	Year						
Parameters	1998	1999	2000	2001	2002	2003	2004
BOD (ppm)	3.40	1.12	3.15	2.03	20.0	2.3	1.23
DO (ppm)	6.34	5.64	6.50	6.60	5.8	5.2	5.68
Cl (ppm)	20.00	32.00	20.00	60.00	40.0	82.0	450.00
Fe (ppm)	0.20	0.30	0.20	0.30	0.2	0.2	0.2
pH	7.50	8.10	8.40	7.80	7.2	7.6	7.5
Temp (°C)	30.00	27.00	29.00	28.50	27.0	28.0	23.00

Table 10: Research adjacent to plant area to and about 1/2 km south of Rupsha river, March 2004 1700 h.

	Samples				
Parameters	1	2	3	Average	SD
BOD (ppm)	121.30	121.6	122.0	121.63	0.35
DO (ppm)	7.50	7.2	6.9	7.20	0.30
Cl (ppm)	254.00	253.0	253.0	253.33	0.58
COD (ppm)	233.00	231.5	232.0	232.17	0.76
Fe (ppm)	0.35	0.3	0.3	0.30	0.03
pH	7.10	7.3	7.2	7.20	0.10
Temp (°C)	28.50	28.9	28.3	28.57	0.31

Table 11: Disease statuses due to the waste practice (n = 70)

Disease	Percent	No. of respondent
None	47	33
Asthma	7	5
Diarrhea	31	22
Dysentery	9	6
Skin Disease.	6	4

results the high BOD and Chloride in water body. The similar result was of BOD was found by Khulna university research cell (Saha, 2001). In that report, BOD was found during low tide 123 mg^{-1} and during high tide about 165 mg^{-1}. The chloride content was found in that report about 4320 mg^{-1} and 6113 mg^{-1} during low and high tide respectively. The temperature, pH and DO are not so alarming for the water animals because the river is tidal. However the water becomes unusable f or other open resource users such as agricultural purpose and as toiletries for the surrounding peoples.

Disease: The frequency of four major diseases has been reported in the study area. It has been showed that, about 31, 9 and 4% has been suffering for diarrhea, dysentery and skin disease respectively while about 47% respondent has not been experienced any vital disease for the processing method. About 6% has experienced with asthma (Table 11) The dominance of diarrhea and dysentery, both of which are water borne diseases (Anonymous, 2004). Therefore, it suggests that the respondents were used the nearby polluted water for the

Table 12: Relevant problems due to current waste practice (n = 70)

Relevant prob.	Percent	No. of respondent
Water pollution	73	51
Bad smell	27	19

Table 13: Weighted average index for the traditional drying method (n = 70)

Constraints	Weighted average index	Std. deviation	Std. error of mean	Overall status	T-test (P≤0.05)
Lack of technology	0.78	0.33	3.905E-02	Strongly agree	0.000*
Weather	0.77	0.31	3.659E-02	Strongly agree	0.000*
Lack of support	0.76	0.31	3.734E-02	Strongly agree	0.000*
Lack of place	0.66	0.32	3.813E-02	Neutral	0.000*
Lack of raw waste cost regulation	0.79	0.28	3.347E-02	Strongly agree	0.000*
Political effluence	0.81	0.27	3.235E-02	Strongly agree	0.000*
Lack of coordination	0.69	0.27	3.285E-02	Neutral	0.000*
Facility					
High demand of product	0.77	0.31	3.680E-02	Strongly agree	0.000*

Note: *indicates statistically significant at 95% confidence level (p = 0.05)

toiletries and sometime for drinking purpose because the drinking and cooking water source in the study area is hand tube well and the waste processor group people were not much aware to use the tube well water for their daily needs. This might cause such type of diseases. While the asthma might be due to the effluent during the drying and some other reason, is not clear.

Relevant problems: About 73% respondent agreed about water pollution while 27% revealed very bad smell around the area of drying (Table 12). It suggests, openly drying of the shrimp wastes and effluent discharge should be regulating in a proper way.

Facilities and constraints of the waste processor: There were eight different questions related with the waste processing scored by the waste processors from 1-5. Then weights have been given to the scores and the average value was calculated which revealed the magnitude of the causes as mentioned before.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
0	0.25	0.5	0.75	1.00

From the Table 13, the result expresses, lack of technology, weather, lack of support, lack of raw waste cost regulation, political influence were the most important problem identified by the interviewed processor as strongly agreed. While the waste processors were showed indeterminate character when responding about lack of place and lack of coordination as a constraint. However, there is a significant difference among the respondent answering of the question. This suggests they need education and training to build up and understanding themselves that what is needed. In addition, it also suggests, shrimp waste processing is a new practice in the study area therefore no technology for processing has been introduced and they suggested about a feasible technology with proper support i.e., various suitable technology demonstration, loan and training. Middle man are the raw waste supplier to the local waste processors, sometime the middleman might demand extra for the waste. This express, a raw waste cost should be regulated by processing plant or the department of Fisheries. People has been very badly experienced by the political influences and in the study area they do not like to have any more influence regarding the allocation of open resource and demanding money. In addition processors were inactive to response about authorized place because they might expects the technology which don't need much place and they were not much acquainted with the sector wise coordination, because there might need some extension training and education about this.

CONCLUSIONS

1. High demand of dried waste product was strongly agreed by the interviewed processors showed shrimp waste processing in a drying method could be an impressive arena for the local people. It revealed, if they could use locally feasible and easy technology like solar drier, or fermentation, the product quality might more better than the traditional method and more demandable.
2. Shrimp waste consists mainly of shrimp heads and tail hulls. Giant tiger shrimp, *Penaeus monodon* consists of about 35% waste of the total weight. Only 28% is processed as sun drying in open place and some others are being utilized as alternative feed for cat fish, white fish culture pond or in shrimp culture pond. There is no data about the fresh water giant prawn, *Macrobrachium rosenbergii* (Golda). However, shrimp waste could be a very good item for value addition in the study area.

3. It was observed that, among total of 1580 people, about 30% was female with considerable number of young people are involved in the waste processing. The waste processors are mainly involved from the month of April to August. Though the temperature and sunshine hour was enough to dry but the problem was the rain. The processors couldn't move the waste in the monsoon as they kept it in open sun. The nature of waste is very perishable in high temperature and humidity and it could degrade the quality. Therefore, solar drier could introduce to reduce spoilage of shrimp waste.
4. It was found that the income from the waste was less than half (13%) of annual total income. The processors are interested to go ahead because of the raw material availability and the dried product demand which is most promising. Therefore, they need to be aware and to understand the dried product quality through government or non government extension work including the suggestion and cooperation of this venture.
5. According to 73% respondents, the water become polluted and they also suffering from some water borne disease like diarrhea (31%) and dysentery (9%).However, the reason of the disease is not proved, when the waste dumped in to the water body or traditional sun drying method practiced in an open place, problems are found as high BOD in river water and bad smell surrounding the processing area. This indicates the abnormal situation of water quality for the fisheries and other resource users. If they practice the method in such a way that could provide the maximum drying rate for economic efficiency, microbiological quality and the minimum loss of essential components of the dried material. Therefore the solar drying method could be a good solution of water quality. So, it could be concluded that more research is needed to understand the whole situation about the disease and the water quality.
6. Pure water supply is an important to become a healthy life, in the study area but the bottleneck in the study area is most of hand tube well is out of work. Therefore, a comprehensive scheme is required to extension and repair to cater the water supply need.
7. There are some negative interactions among the other stakeholders, which express that if a technology could be there the problems might not happen any more. In addition they strongly agreed about the political interference were disturbing them to do the processing smoothly. For better management, about 45% interviewee revealed, cooperation with the waste processors, processing plant, civil society, government and private sector should pay the attention. This concludes that the waste practice though new, but people have interest to do this better with the help of other sectors. While they did not know about various departmental coordination. Therefore, the relevant sectors could work themselves specially department of environment (DOE), department of fisheries (DOF) and other concern private agencies to provide them knowledge about relevant field and make more understand about their demand and expectation.
8. Waste dumping could regulate with some valid and practical rules for the environmental protection and management. DOE could allocate space for the deheading of shrimp. Processing plants could maintain the raw material quality as possible as fresh for the further process of the waste.

Therefore, processing practice with easy technology should be done on the most suitable method.

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