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Solar Drying as an Option for Shrimp Processing Biowaste in Khulna District-Southwest Bangladesh

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Abstract: The study was conducted with a drying trial with traditional and solar dryer to assess solar dryer as an option for post processing shrimp bio-waste in Khulna district. Products of traditional and solar drying method indicates a significant difference among protein, lipid, moisture, fiber and calcium content except nitrogen free extract, suggesting the product quality was highest in solar drying method. Therefore this needs to be support research, training and technology demonstration for effective waste drying. Solar driers are small-scale engineering with low-cost locally available materials and could be operated close to the user's house. Solar drier could increase the temperature almost double and very efficient to dry. In addition it could be a very appreciable technique to dry shrimp waste in the study area regarding the weather constraint. It could provide faster and more hygienic condition than traditional sundryer appears most suitable for the limited income processors. The cost benefit ratio revealed solar drying method is very much applicable and could increase benefit.

Key words: Biowaste, option, shrimp, processing, solar dryer

INTRODUCTION

Waste from post harvest shrimp processing losses is defined as biowaste. 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. About 30-45% by weight, shrimp raw material is discarded as waste when processed shrimp is headless, shell on products. Peeling process involves removal of shell from prawn; increase the total waste production up to 45% (Subashinghe, 1999). Shrimp waste could be processed in drying, fermentation, ensilation for recycle use such as shrimp meal, fishmeal, poultry meal, a natural source of carotenoids and human foods. Shrimp meal is an important product of shrimp waste (Ariyani, 1989; Widarto, 1989). Shrimp meal is valuable in tropical fish, poultry 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). In Bangladesh shrimp industries play a vital role in the national economy. Export processed shrimp has become a major income earner of the country and its contribution to in export earning is rapidly increasing. With a present capacity of 41,577 Mt year^{-1} in 127 processing plants (Anonymous, 2003a), the frozen food industry has become the second largest export sector contributing 5.9% to national gross domestic product (Anonymous, 2003a). Although no systematic studies have so far been done on the total amounts of wastes produced and their utilization in Bangladesh, it is estimated that about 13,678 Mt year^{-1} of shrimp head is produced annually from the shrimp processing industries located in the Khulna region. A small portion of shrimp waste (*Macrobrachium rosenbergii*) is collected for sun drying by low-income consumers. The collected part of wastes is dried through traditional sun drying in open place. The problem associated with this practice is, under humid and high temperature conditions decomposition of the waste occurs more rapidly because these contain protein, fat which are easily degraded, producing organic compound (Superno and Poernomo, 1992). The limited utilization of shrimp bio waste is due to the lack of technical method than the traditional (Stevens, 1996). Hence the present study was undertaken to assess the product quality in solar dryer and traditional open drying method for post processing shrimp biowaste in Khulna district- Southwest Bangladesh.

MATERIALS AND METHODS

Most of the shrimp processing plants and waste processors are concentrated in and around Khulna district. Semi-structured and structured questionnaire

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Fig. 1: A solar dryer

along with observation has conducted for interviews with the shrimp waste processors (here processors refers the people who are involved with shrimp head and tail hull drying process), drying trial with traditional and solar dryer has been conducted. Shrimp processing waste was collected from 5 plants in one sampling day within the Khulna district. On March 20, 2004, about 300 kg of shrimp waste (*Penaeus monodon*) were collected and distributed in three places as three replication (100 kg in each) for both traditional and solar drying method.

The solar dryer was made from locally available materials. The dryer base made from steel pate was about 5 ft. length and 2.5 ft. wide with a height of 2.5 ft. The sheet was placed and tied with bamboo pole. Therefore the height of the drier from ground was about 3.5 ft (Fig. 1). Three units of solar drier were constructed with a same configuration. The temperature, moisture content were recorded upto drying completed and after drying waste were taken for laboratory analysis. Proximate composition of traditional drying and solar drying product were analysed by the standard method (Anonymous, 1992). The statistical package for social science (SPSS) and excel were used for data processing and data analysis in this study t-test was applied to test the statistical difference of quantitative data (proximate composition in traditional and solar drying).

Area description: Khulna is the southwestern coastal city of Bangladesh. Khulna district is occupied an area of 4334.46 km^2 (Anonymous, 2003a), stands on the bank of the river Rupsha and Bhairab. Geographically, Khulna lies between 22^{0}49' north latitude and 89^{0}34' east longitude. Khulna district has the great potential of shrimp culture, processing and thus waste delivered. Among total licensed processing plants in Bangladesh, about 80% are situated in this region. A total 34 processing plants has established in Khulna district.

RESULTS

The traditional open sun method did not change the temperature and depends upon the air temperature, the trial begin (at 7.00 am) with 28°C and reached the highest 32°C after 8 h. In night the temperature gradually decreased to 29°C and again increased unto next 32 h about 31°C. While internal temperature of solar drier showed increased steadily from 28°C to 44°C during the first 8 h then followed by a decreased rate up to 24 h and increased in the next 32 h and the temperature change was followed almost nearly of first 24 h (Fig. 2). The humidity was about 75%. The temperature-changing pattern was related to a solar simulated drier followed tropical sun (Fox *et al*., 1993).

Total time for drying was recorded 25 days for traditional method and 7 days for solar method. Average nutrients (protein, lipid, fiber, calcium) content in solar dried product were significantly higher than that of traditional dried product (Table 1). Moisture and ash content in solar dried product was significantly lower than that of traditional dried product (Table 1).

Solar drier took 7 days to dry enough while in the traditional open sun drying took 25 days in this trial; typically it often took more than one month. The construction and operational cost of solar drier could get back by 2 years of drying practice and solar dryer could operate thrice/month (Table 2).

The waste processors interaction with other stakeholder group has been plotted Table 3. Both conflict and cooperation in existing situation might find out the gaps and at the same time probable ways to improve the situation. With a group discussion they expressed that, the cooperation with the same group will continue if they have a solution of the open place by a technology that could meet the place and the weather as well. With the middleman the deal was also

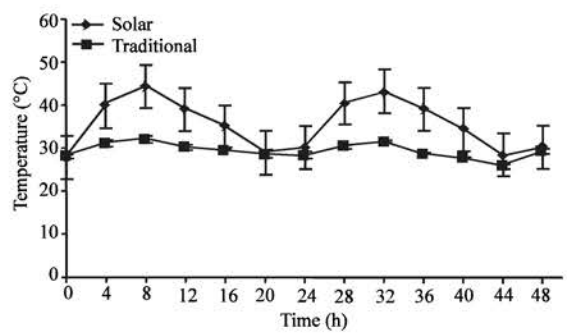

Fig. 2: Change the temperature of traditional drying and solar drier method within 48 h (vertical lines indicate±standard deviation)

Table 1: Proximate composition (%) and Calcium contents (%) of solar and traditional dried products with some reference

Composition	Methods: Solar	Methods: Traditional	Acid ensilage (Meyers, 1986)	Sun dried of shell (Suwannachart and Pichyanghura, 1996)
Protein	52.4±0.26[a]	25.79±0.25[b]	69.0/51.7 (sun dried)	48.4
Lipid	10.72±0.25[a]	5.33±0.15[b]	6.8	1.7
Moisture	10.73±0.18[a]	30.53±0.25[b]	7.0	10.1
Ash	16.78±0.19[a]	31.12±0.21[b]	17.8	25.4
Fiber	7.54±0.22[a]	5.36±0.21[b]	-	-
NFE	1.82±0.21[a]	1.44±0.21[a]	-	-
Calcium	8.4±0.19[a]	2.2±0.18[b]	5.29/11.12 (Legarreta *et al*., 1996)	

Note: Row means bearing non-identical superscripts are statistically significant at 95% confidence level (P=0.05)

Table 2: Cost benefit analysis of traditional and solar dryer method

Item	Solar method: Quantity	Solar method: Price Tk. Unit^{-1}	Solar method: Amount (Tk.)	Traditional method: Quantity	Traditional method: Price Tk. Unit^{-1}	Traditional method: Amount (Tk.)
Construction cost						
Bamboo, net, plain sheet, polythene sheet, dye, screw.	-	-	1242.5	0	0	0
Labor	3(1person x 3dys)	80.0	240.0	0	0	0
Operational cost year^{-1}						
No. of production month^{-1}	15					
Raw material (kg)	1500	3	4500	500	3	1500
Repairing cost (net, dye, 1 labor, polythene sheet)			166.25			
Subtotal			4666.25			
Total cost/investment (Tk.)			6148.75			
Total dry waste production (kg)	375			100		
Sales per unit (Tk. kg^{-1})	1kg	25			20	
Gross benefit (Tk.)	0		9375			2000
Net benefit (Tk.)	0		3226.25			500
Cost benefit ratio (after 1 year)	0		0.50			0.33
Cost benefit ratio (after 2 year)			1.01			0.33

good until it comes to a monetary conflict i.e., he can control the price of the shrimp waste. In addition the money lender also could demand unfair interest to them. Therefore they need to link with some bank to provide money in a reliable interest. However, the local people were found friendly to the processor until the bad smell of the traditional drying method unlikely to the political person while they are demanding money. There is almost neutral interaction with the processing plant. While department of environment play a role to provide rules to deal environment friendly but sometime they did not give the solution against the local people even the processing plants also claim that the department of environment are not working with actual alternative of any environment related deal like dumping of the waste but DOE did not tell where to do the waste practice. Both department were interviewed and revealed some time DOE provide some rule but DOF personnel's even don't informed that properly and vice versa. This suggests, a good collaboration is very essential to do this type of work properly. By training program the DOE and DOF could take a part to be aware the local people about their task, the technology they are going to introduce and the benefit they will gain from the method.

DISCUSSION

In solar drying method, polythene was used as dryer roof acts as insulator and the dryer base was black colored which retaind and increased the internal temperature. Solar drier could increase the temperature almost double and very efficient to dry. In addition it could be a very appreciable technique to dry shrimp waste in the study area regarding the weather constraint. Shrimp waste is degradable in high temperature and humidity. For drying in open public place it is difficult to get free access. Superno and Poernomo (1992) observed the limited processing because of the perishable nature of the waste. Thus, it suggests, it is worth-while to develop and implement a new technology, which is simple and affordable. Therefore a solar dryer could be introduced to solve the open place difficulties. Suitable and easy technology like a solar drier, the product quality might better than the traditional method and they will earn more income.

Protein, lipid, fiber and calcium content in solar dried product was highest it may be due to protection from the rainfall and small scale engineering pattern of solar dryer which enhanced the drying faster and keeps the

Table 3: Interaction with others stakeholders

Stakeholders	Cooperation	Conflict
Waste processor- waste processor	i. Help one another ii. Supply food to each other if needed iii. Convey information	i. Conflict to regarding to use the open place ii. Conflict after the time of poaching
Waste processor -middleman	i. Middleman make easy access to get waste ii. Try to serve the users when they are not able to pay fully.	i. Sometimes conflict regarding to payment middleman ii. Conflict about the condition of waste
Waste processor -money lender	i. When users don't process waste the money lender ii. Pardon them from their payback %.	i. Some time money lender claim too much interest from the user
Waste processor local resident	i. Help one another in common issue ii. Cooperation in any large issue	i. Sometimes conflict regarding the bad smell of waste ii. Sometime Conflict about the community health
Waste processor Political person	i. Cooperation during danger, sometime provide security. ii. Help to use the open resource	i. Sometime claim illegal payment from the users. ii. Conflict about allocation of the place for use
Waste processor-processing plant	i. Plants make the access to the users to use waste and user can not get	i. Sometime plants dump the waste
Waste processor-department of environment	i. Sometime they help to understand the community environment by monitoring the rules	i. Sometime they monitor and take decision with particle solution
Waste processor-department of fisheries	i. Provide security to the waste user ii. Cooperate with waste users if asking	i. Conflict with users because Govt. did not allocate a particle place to process ii. Sometime no collaboration among work
DOE-DOF	i. Provide monitoring and rules	i. They blame to each other, personnel of each do not willing to follow the others rules
Processing plant-DOE-DOF	i. Provide rules for environment friendly ii. Monitor	i. Personnel's sometime claim illegally more money ii. Sometime conflict due to DOE provide rules plant said they do not know what to do and where to go for deheading. Because no place allocated by DOF and DOE for deheading environmentally friendly.

nutrients in a good quality while traditional dried product might infected by flies, microbial activity which caused the degradation and deterioration of nutrients. Protein content in solar dried product in this study is comparable with sun dried shrimp meal (Meyers, 1986) but he found higher protein than this study in shrimp head meal (about 58%) and acid ensilage of shrimp waste constituted about 59% protein (Table 1). From sun-dried shell, protein content was lower (Suwannachart and Pichyanghura, 1996) than this study. Fox *et al.* (1993) reported 44.4% protein from shrimp head stored at -20°C, the protein was less than this study. However, protein content in solar dried product in this study was quite high and it could be possible to recover protein from shrimp biowaste for further value addition. Lipid content in solar dried product in this study showed higher than acid ensilage method (Meyers, 1986) and sun dried shrimp shell (Suwannachart and Pichyanghura, 1996). Moisture content in solar dried product in this study was comparable with sun dried shrimp shell (Suwannachart and Pichyanghura, 1996) but acid ensilage method contains less moisture (Meyers, 1986). Higher moisture content in traditional dried product may due to no management for protection from rainfall in addition to lower amount of evaporation under lower temperature. High moisture content in traditional method encourages physical spoilage due to insect attack both from flies (maggots) and beetles, which accelerate spoilage (Doe, 1998). Physical losses owing to further processing's being carried out when the produce is too wet (Anonymous, 1995). Moisture content needs to be reduced to about 25 % or less (http://www.fao.org/WAIRdocs/x5434e/x5434e0f.htm). Ash content in traditional dried product was significantly higher than solar dried product (Table 1). This may due to the traditional drying method enhance microbial deterioration of product hence, cause of quality and physical loss. It also supports contaminated by sand grains (De Silva and Anderson, 1995). Ash content in solar dried product in this study was comparable with acid ensilage of waste (Meyers, 1986) and lower than sun dried shrimp shell (Suwannachart and Pichyanghura, 1996). This may be due to Suwannachart and Pichyanghura did drying of shell and the ash content in dried shell was higher than the solar dried heads and tail in this study. However, proximate compositions of shrimp vary due to the location, nutrition, among and between the species and season (Cobb and Vanderzant, 1975). Though traditional drying method is inexpensive, but results in quality loss due to spoilage and contamination (Doe, 1998). Thus, solar drying method could achieve a budget more surplus.

CONCLUSIONS

The results suggest the product quality highest in solar drying method. Solar driers are small-scale engineering with low-cost locally available materials and could be operated close to the user's house. It could provide faster and more hygienic condition than traditional sundryer appears most suitable for the limited income processors with a transparent roof, which acts as an insulator. A lack of refrigerating facility with the available seasonal raw material supply in the study area, solar dryer could provide means of sanitary product and also a means of generating income to limited income processors. As the Processors are not much aware about the quality, they need the advice from the governmental or non-governmental organization to understand the know- how.

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