

PILOT PLANT FOR PRODUCTION OF FISH ENSILAGE AND THE ECONOMICS OF PRODUCTION

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This communication describes the design aspect and functions of individual pieces of equipment of a pilot plant for the production of fish ensilage based on lactic acid fermentation process. Details about the equipment, process flow sheet and equipment layout of the pilot plant have been given. An attempt has been made to prepare an estimate of the cost of production of liquid ensilage and solid feed mix.

INTRODUCTION

Fish ensilage as an alternative animal feed in place of conventional fish meal from miscellaneous fishes and fish waste has been suggested by many workers (Edin, 1940; Olsson, 1942; Petersen, 1951; Hanson, 1951; Freeman *et al.*, 1956; Sperling, 1959; McBride *et al.*, 1961 and Tattersson and Windsor, 1974) and the nutritional aspect of fish ensilage from freshwater species has been studied by Krishnaswami (1965). Liquid fish ensilage can be prepared by using mineral acids or formic acid or by lactic acid produced by microbial fermentation. Of these processes, the fermentation process is better as reported by Nilsson (1961) because the product can be used for direct feeding to animal while in the other case, the mineral acid has to be neutralised before feeding to animal.

Unlike fish meal, it does not require any dilution with other feeding stuff (Windsor, 1974) due to low concentration of protein compared to fish meal.

In India, James (1966) outlined a method for fish ensilage production using lactic acid fermentation of pre-cooked fish in presence of *Lactobacillus plantarum* NCIB 6105. The product was found to be an ideal nutritional supplement to animal diet as reported by James (*op. cit.*). The present communication pertains to the design of a pilot plant based on the same process.

MATERIAL AND METHODS

Fish ensilage is prepared from edible variety of miscellaneous fishes like jew fish (*Pesudosciana spp.*), silver bellies (*Leio gnathus spp.*), spratts (*Anchoviella spp.*)

and fish waste by the process described by James (*op. cit.*).

Equipment and their functions:

Fish ensilage pilot plant comprises of the following pieces of equipment having capacity to handle 250 kg. of raw material per batch.

i) Concrete washing tank:

This is required for washing the raw material to remove sand, dirt and other extraneous matter. The tank is fitted with water inlet pipe and an outlet drain pipe with a gate valve for removing dirty water.

ii) Meat mincer:

Helical type continuous meat mincer

LAYOUT

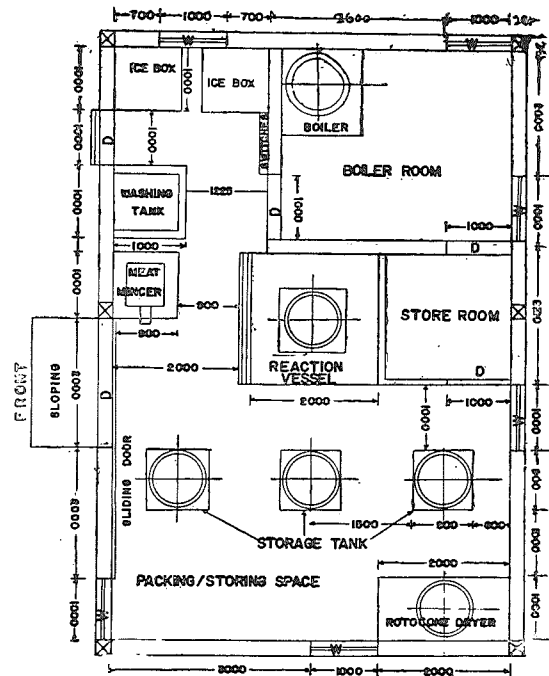


Fig. 2

FLOW SHEET

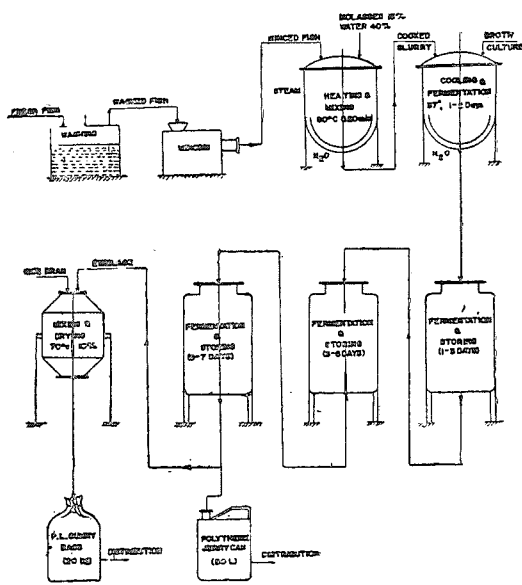


Fig. 1

is used for mincing raw fish. The purpose of mincing is to reduce the size of the muscle thereby helping in cooking process and for getting homogenous minced mass from different types of fishes. The mincer is fitted with reduction gear motor, electrical drive system with reversing switch, different sizes of perforated extruder plates, working platform etc.

iii) Stainless steel reaction vessel:

This is a steam jacketed type reaction vessel with an air tight cover lid. The vessel is fitted with steam/water jacket, anchor type agitator drive system, charg-

ing and discharging doors, dial thermometer and other standard fittings.

The vessel is used for two main purposes viz., cooking and fermentation. The raw minced mass is mixed with required amount of water (approx. 30%) and molasses (15%) and cooked (20 minutes at 90°C) using steam while stirring. The cooked mass which is sterile is cooled by passing cold water in the jacket, fermenting agent added and is allowed to ferment for 1-2 days vigorously under constant agitation. The vessel is installed at higher level (1.5 metres) than the equipment number iv for transferring the material by gravity flow.

iv) Concrete storage cum fermenter tank:

The concrete tank is a closed vessel with wide charging and discharging doors. Discharge door is fitted with discharge pipe and a gate valve. This tank is fitted with hand laddle. This serves as

storage cum fermenter tank. Partially fermented mass from iii is drained by gravity using a hose pipe into the vessel and fermentation is allowed to continue for 6 to 7 days till complete (PH 4). From this vessel fish ensilage is filled directly in the final storage and distribution container.

v) Rotocone blender cum dryer:

This machine is used for the preparation of solid feed mix. Fish ensilage is mixed with deoiled rice bran in the proportion of 1:1 or 2:1 and dried at 70°C to 10% moisture level simultaneously in this machine. The machine is fitted with steam jacket, charging and discharging door, dial thermometer, standard steam fittings and geared motor electrical drive system for rotating the dryer. Product from dryer can be directly fed into polyethylene lined gunny bags for storage and distribution.

Details about the process and equipment have been indicated in the flow sheet and layout (Fig. 1 & 2)

Estimate of the economics of production of fish ensilage and dry feed mix

I. Total space requirement (Minimum)

1) Total land (15 m. x 10 m.):	150 sq. m.	1,500.00
2) Built up area (9.5 m. x 6.5 m.):	62 sq. m.	
	@ Rs. 350/- per sq. m.	19,200.00
		<hr/> 20,700.00

II. Machinery and equipment

1) Wood/coal fired low capacity boiler (100 kg./hr., 5.5 to 7 kg./cm ² .)	1 No.	12,000.00
completed with fittings, accessories		
2) Cemented washing tank: Capacity: 490 litres	1 No.	400.00
Completed with fittings		

3) Heavy duty screw type meat mincer Capacity: 100 kg./hr. Completed with accessories and fittings	1 No.	5,000.00
4) Stainless steel reaction vessel Capacity: 412.5 litres. Completed with agitator drive system, accessories, fittings	1 No.	40,000.00
5) Concrete storage cum fermenter tank Capacity: 375 litres. Completed with fittings	3 Nos.	9,000.00
6) Rotocone blender cum dryer Capacity: 375 litres. Completed with accessories and standard fittings	1 No.	25,000.00
7) Water pump set & overhead tank (200 litres)	1 set	2,500.00
8) Platform balance: Capacity: 100 kg.	1 No.	1,500.00
9) Ice box; 1 cu. m.	2 Nos.	5,000.00
10) Plastic buckets of 15 litres capacity	6 Nos.	90.00
11) G. I. tubes (or Al.) of 50 litres capacity	6 Nos.	600.00
12) Plumbing, steam and water line fittings		6,000.00
13) Electrical wiring and fittings		2,000.00
14) Installation of machinery		3,000.00
15) Miscellaneous		2,000.00
		Rs. 1,14,090.00

III. Recurring expenditure

(Basis: 250 days/year, 125 days/year for each product)

	Ensilage	Feed mix
a) Fuel, water & electricity		
i) Fire wood at 16 kg./hr., 5 hrs./day @ Rs. 100/- per tonne, 10 tons per year	1,000.00	1,000.00
ii) Electricity: 25 KW/day @ 15 ps./unit.	500.00	500.00
b) Raw material		
i) 250 kg. fish/day, 31.25 tonnes/year each @ Rs. 500/- per tonne	15,725.00	15,725.00
ii) Molasses: 37.5 kg./day, 5 tonnes/year @ Rs. 100/- per tonne.	500.00	500.00
iii) Rice bran, 300 kg./day, 37.5 tonnes/year @ Rs. 50/- per tonne	—	16,750.00
iv) Jerry cans, 50 litres. capacity, 6 per day x 125, @ Rs. 100/- each	7,500.00	—
v) Poly. lined jute bags, 25 kg. capacity 16 per day x 125, @ Rs. 3.50 each	—	7,000.00

c) Labour charges			
i) Casual labour, 3 Nos. @ Rs. 6/- day	2,250.00		2,250.00
ii) Boiler man cum mechanic @ Rs. 200/-p-m, 6 months each	1 No.	1,200.00	1,200.00
d) Wastage and unforeseen		1,000.00	1,000.00
		<u>Rs. 29,675.00</u>	<u>Rs. 47,925.00</u>

Summary:

Fixed capital			
Land and Building:	Rs.	20,700.00	
Machinery/equipment:	Rs.	1,14,090.00	
Total	Rs.	1,34,790.00 =	Rs. 1,35,000.00 (approx)
Working capital for ensilage:	Rs.	15,000.00	
Working capital for feed mix		24,000.00	

Cost of production	Ensilage	Feed mix
Depreciation on building @ 5% (say on 21,000.00)	525.00	525.00
Depreciation on machinery & equipment at 10% (on 1,14,000.00)	5,700.00	5,700.00
Interest on locked up capital at 10% (on 1,33,300.00)	6,665.00	6,665.00
Profit on working capital at 15% (on 15,000.00 and 24,000.00)	2,250.00	3,600.00
Recurring expenditure III	29,675.00	47,925.00
	<u>Rs. 44,815.00</u>	<u>Rs. 64,415.00</u>

Yield of ensilage : 37.5 tonnes/year

Yield of feed mix : 50 tonnes/year

Cost of production of ensilage : Rs. 1300.00 per tonne.

Cost of production of feed mix: Rs. 1300.00 per tonne.

DISCUSSION

In the preparation of the pilot plant design for fish ensilage special attention has been paid in the selection of equipment to keep the plant cost low. In this integrated plant provision has been made to prepare both liquid fish ensilage

and dry feed mix to bring down production cost. In order to reduce plant cost, three concrete storage cum fermenter tanks have been used in place of costly stainless steel fermenter and only one stainless steel reaction vessel has been designed to perform several functions like cooking, mixing, sterilization and initial

fermentation. This vessel has been installed at higher level than that of concrete tanks for transferring partially fermented product from stainless steel fermenter by gravity alone. For the production of solid feed mix, only one additional equipment namely rotocone blender dryer has been added up to the main plant. In this design provision has been made to increase the plant capacity considerably by incorporating few more concrete fermenter tanks without much extra cost.

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REFERENCES

- Edin, H. 1940. *Nord. Jordbr. Forsk;* **22** : 142.
- Freeman, H. C. and P. L. Hooland. 1956. *Fish. Res. Bd. Canada Prog. Report of Atl. Coast Stn;* 65 : 24.
- Hanson, S. W. F. and J. A. Lovarn. 1951. *Fish. News;* 1988 : 11.
- Hassen, P. 1958. *Meddr. Fisk. Minist. Fors. Lab;* May : 1.
- James Arul. 1966. *Fish. Technol;* **3**, 1 : 38.
- Krishnaswami, M. A., S. B. Kadkol and G. D. Revankar. 1965. *Canadian J. Bio-chem;* **4**, 3 : 283.
- McBride, J. R., D. R. Idler and R. A. McLeod. 1961. *J. Fish. Res. Bd. Canada;* **18**, 1 : 93.
- Nilsson, C. Rand Rydin. 1961. *United Nations Inter Office Memorandum.*
- Olsson, N. 1942. *Lantbrukshogskolans Husdjursforsoksan Stalten;* Report No. 7.
- Petersen, H. 1951. *Mddr. Fisk. Minist. Fors. Lab;* **95** : 1.
- Sperling, L., Albert and F. John. 1959. *Deut. Land Wirtsch;* **11**, 37.
- Tatterson, I. N. and M. L. Windsor. 1974. *J. Sci. Fd. Agric;* **25** : 369.
- Windsor, M. L. 1974. *Fishery Products;* F. A. O. Publication, p. 140.