

**VALUE ADDITION-HOT SMOKED LAKE VICTORIA SARDINE
(*Rastrineobola argentea*) FOR HUMAN CONSUMPTION**

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ABSTRACT

Various traditional methods are employed to preserve and process *Rastrineobola argentea* locally known as dagaa (sardines) an indigenous fish species of Lake Victoria. The widely used known customarily dagaa and dagaa products preservation methods include sun-drying, smoking, salting and various combinations of these. The advantages of smoking dagaa are manifold. Fish smoking prolong shelf life, enhances flavour and increases acceptability and utilization of dagaa. Customarily traditional dagaa processing techniques used by fishers for example sun drying dagaa direct on the unhygienic sand, rocks and or grasses significantly contribute to poor dagaa products. Awareness of the shortcomings of traditional ovens had stimulated development work on new and improved smoking ovens such as Chorkor oven and Nyegezi models ovens for various reasons. In the light of lessons learned from the constraints and disadvantages associated with earlier smoking techniques, an improved dagaa smoking oven, the modified Altona for hot smoking was introduced. Hot smoking means curing fish by smoking at a temperature of 70-80°C at some stage in the process in order to cook the flesh; hot smoked fish products do not require further cooking before consumption. Unlike other fishes, dagaa are readily available at cheaper price. However, smoked dagaa products have not been promoted in the country wide as well for the region and overseas markets. This may be contributed by the main middlemen traders for sun dried dagaa products who are not willing to opt to trade on smoked dagaa products at domestic markets. Because of the high quality of smoked dagaa compile the hygienic environment for storage and selling. This further enables hygienic handling during trading. If smoked dagaa and dagaa products are properly and hygienically handled extends shelf life. The quality of smoked fish is primarily linked to processing and post processing procedures.

INTRODUCTION

Fish and fish products are consumed as food all over the world and it provides the world's prime source of high-quality protein. Fish is one of the most valuable sources of protein food which can be used as medicine, ground into vitamins or processed into cosmetics, lubricants, varnishes, soap and margarine, (1). The quality of smoked fish is primarily linked to processing and post processing procedures. For example, smoking storage, handling and packaging techniques such as the use of used packaging materials like polythene bags papers are sources of contamination. Fish contamination and spoilage is caused by microorganisms. Presence of pathogens such as *salmonella*, *Escherichia coli*,

Staphylococcus aureus, *Bacillus cereus* and *Clostridium botulinum* has raised major concerns to consumers since them food borne illnesses.

The *Rastrineobola argentea* locally known as dagaa (sardines) is an indigenous fish species of Lake Victoria. The name dagaa is also used for *Stolothrissa tanganyicae* and *Limnothrissa miodon* of Lake Tanganyika. Dagaa is one of the most important fish foods for the low-income households in Eastern and Central Africa countries. Dagaa is the second commercially important fishery of Lake Victoria. The fish is consumed by majority around the lake and far hinterland. Unlike other fishes, dagaa are readily available at affordable price. Nevertheless, emphasis on fish quality assurance has been focused more to Nile perch than dagaa and alike, which are sold to local markets. Currently over 98% Lake Victoria sardines are being processed locally by drying on sands, rocks, and grasses which in turn compromises the end products quality and safety. Dagaa processed under unhygienic premises are heavily contaminated, easily deteriorate and become un-favourable for human consumption. The off-flavour and off-odour that results from the traditional sun-drying process of sun-dried dagaa is a major disincentive to the use of the fish for human consumption, because of its low value and quality lead to utilization in animal feed (2). In the past decades dagaa fishery was not recognized as potential source of protein for human consumption, until when the samples appeared in Tanzanian lakeside markets in mid 1960s. After 1970 dagaa appeared in far markets consumed by majority because of its availability and cheaper price than of many other fishes. The fish can be transported to vicinity unlike other fishes because when well preserved like sun dried, they do not easily undergo quantitative spoilage rather than quality spoilage due to oxidation of fats. For the past two decades good quality dried fish were being transported from Kirumba, Mwanza in Tanzania to far markets in Zaire (DRC), Rwanda and Burundi for human consumption. Poor-quality dagaa usually are taken to factories and used as supplements to prepare animal feeds.

Justification and Purpose

Food safety and quality have become increasingly important in international fish trade hence this leads to reduced Food borne illnesses which usually arise from improper handling, preparation, or food storage. Customarily local dagaa processing techniques used by fishers for example sun drying dagaa direct on the unhygienic sand, rocks and or grasses had significantly contributed to poor dagaa products. It is estimated that more than 98% dagaa are dried on sands, grasses and rocks (per. obs.). Therefore the purpose of this paper was intended to suggest and demonstrate modern and better ways of hygienic handling and processing dagaa and to produce the highest possible good quality dagaa products. Further more explore markets in the region, regional and even overseas.

HOT SMOKING BY MODIFIED ALTONA (NYEGEZI OVEN TYPE)

The widely used known customarily fish preservation methods include smoking, salting and sun-drying. Smoking of fish ranges from three hours to two days depending on the desired end product and the shelf life needed for storage and marketing of the product.

The Nyegezi oven - smoking kiln, was designed by the Natural Resources Institute in the United Kingdom, and introduced first to Tanzania and later to Ghana in 1990. It was designed to heat fish solely by convection, isolating the fish from the fire to avoid direct heating by radiation. Air is heated in a furnace and diluted with air at ambient temperatures entering from ventilation holes at the side. After passing through the fish and heating it, the air enters a chimney, which channels it upwards. The suction created draws air into the furnace and dilution vents and maintains the current of hot air passing through the fish.

The oven was originally designed to meet problems that were particularly significant in Tanzania: shortage of fuel, the fatty nature of the fish and the need to prepare a product that could keep for several weeks at ambient temperatures. The modifications included provision of perforated precipitator which filters the smoke before it is in contact with dagaa being smoked. The space between smoking trays is big which allows good space for circulation of heat and smoke. The chimney is wide in diameter which allows rapid evacuation of smoke. Smoking tray made of wire mesh. The precipitator can be made using bricks, perforated heavy iron plates etc.

HOT SMOKING HANDLING STEPS – SMOKED LAKE VICTORIA SARDINES (*Rastrineobola argentea*)

Fishing and procuring: Fishing is done over night. Figure 1-4 shows that raw dagaa procured from the landing sites and immediately transport to the processing area. The time is from 30 minutes to 60 minutes.



Figure 1: Kijiweni landing site for Dagaa Nyegezi Bay



Figure 2: Auctioning Raw Dagaa at Kijiweni Landing site at Nyegezi Bay



Figure 3: Procured Raw Dagaa

Washing: Receive raw dagaa and thoroughly wash with clean drinking water and sorted to remove snails, by catches in particular ‘furu’ and wastes. *Time* is 1- 2 hours.



Figure 4: Washing raw dagaa

Brining: Place in 3% brine solution and retained for about 30-45minutes

Dripping and semi sun-drying: Place on to the wire mesh racks to drip and spread drying wire mesh racks to allow complete drip and semi-dry under the sunny. Time is 2-4 hours allow more time if weather is not good. *See figure 5.*



Figure 5: Semi-dried dagaa ready for smoking

Hot smoking: Place semi dried dagaa in the smoking wire mesh racks and load in to smoking kiln which is pre heated with fire. During smoking, monitor until when dagaa are well smoked and become completely dry. This may take between 3-4 hours. *See figure 6.*



Figure 6: Hot smoker, Modified Nyegezi Altona

Cooling, final sorting and packaging: Offloaded smoked dagaa and thoroughly cool. Sort remaining filth and furu. Weigh i.e. 100g, 150g, 200g and 250g in polythene bags and seal by sealing machine. *See figure 7.*



Figure 7: Packed Hot Smoked Lake Victoria Sardine/Dagaa (*Rastrineobola argentea*)

Storage and distribution: packaged dagaa products may be stored up to one year. Storage must be at dry environment and free from insects.

Utilization: Hot smoked dagaa products can be direct consumed as snacks or seasoned or roasted or as supplement side dishes.

COST-BENEFIT ANALYSIS ON HOT SMOKED DAGAA

Table 1 below shows cost analysis for buying, processing and labour involved through out processing chain for dagaa and dagaa products. The total cost of production is amounting to TZS 47,000/= which round figure of TZS 50,000/=. This is cost for processing very minimum quantity of dagaa per day. Depending on the processing premises facilities and space availability the production can increase by more than double and even more if the production can take full day, i.e. 24 hours with day and night smoking. This minimum quantity is sought because of fixed cost like fire wood and labour which may not change. Where as same labour force and fire wood will remain constant even if the quantity of raw dagaa which is enough to be smoked at one time increased. However the cost involved will double if the quantity is increased to extent that will be done during day and night to make two shifts.

Table 1: Cost involved for buying and smoking dagaa.

S/N	ACTIVITY	RATE IN TZS	COST IN TZS	COST IN US\$
1	Two (2) buckets	15,000	30,000	20
2	Smoking fire wood	5,000	5,000	4
3	Two personnel (labour)	4,000	8,000	6
4	Packaging materials and machine	4,000	4,000	2
TOTAL			47,000	32

The table 2 and figure 8 below show selling prices and margin profit for dagaa products which have been smoked from two buckets and smoked dagaa products approximately 8 kgs. The different packages size and corresponding selling prices ranging from 40gm to 1000g and selling prices from TZS 500/= to TZS 8,000/= which generate total revenue between TZS 106,667/= and 64,000/= minimum respectively. Therefore from the figure 8 below indicates that the minimum margin profit is TZS 14,000/= (64,000 – 50,000) and maximum margin profit is TZS 50,000/= (100,000 – 50,000). The best average cost benefit would be for packages of 100gm, 150gm, 200gm and 250gm as depicted in the figure 1 below. In this pilot example the margin profit is TZS 30,000/=. The most economical (cost effective) among these ranges of packages are 100gm and 200gm.

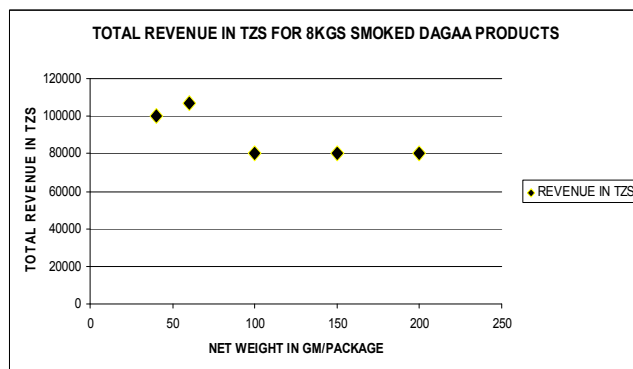


Figure 8: Sales for different packaged weights

PERCEPTION AND PREFERENCE OF CONSUMERS

According to appendix II, out of 25 respondents only 36% are trading in dagaa products while 60% are in various fishery products. 68% of respondents consume dagaa products and 76% they do not consume dagaa products. Majority i.e. 80% they showed that they are very interested in dagaa trading while minority i.e.20% was interested. Whereas 68% were interested in smoked dagaa products and 32% showed interest in sun dried dagaa. All respondents liked smoked dagaa products. 92% accepted the product, and only 8% did not. The sequence of packages and price acceptability preferred was 100gm (44%), 200g (24%), 40gm (12%), 250gm (8%) and last 60gm and 1000gm each 4%. The 60%, 24% and 16% of respondents showed that they can consume <100Kg, >100Kg and >1000Kg respectively per annum. Majority of respondents showed that they would prefer product certification and they will pay premium for the certified dagaa products. Dagaa products competitors, out of 100%; 48% mentioned other fish products, 28% they urged that no competitors against the product while 16% listed green vegetables the rest mentioned beef and chicken at 4%. The general opinions and comments by respondents, 64% were positively commented while 36% not. 88% respondents they positively commented and interested on smoked dagaa products and the rest 12% negatively commented on the product.

CHALLENGES ON HOT SMOKED DAGAA BUSINESS

Many challenges encountered during selling smoked dagaa products are due to several reasons which may include: middlemen traders for sun dried dagaa products are not willing to opt to trade on smoked dagaa products at domestic markets. Poor infrastructure status of domestic markets premises which do not have a favourable storage environment. Since smoked dagaa products storage conditions are compromising. If they are exposed at ambient moist temperatures they absorb moisture and can spoil hence shortening storage time by infesting spoilage microorganisms and destructive insects. This is because the market premises environment is not well designed, kept clean and no fumigation at all, hence they are prone of various destructive rodents and insects. Dagaa products processors are not willing to invest more on the smoking industry because there is no envisaged ready market for their products. They have not being able to undertake market promotion for the smoked dagaa products. There are few supermarkets and shops which display smoked dagaa products and consumers are used to buy. Few retail traders are selling in house or office doors. Smoked dagaa products have not been promoted in the country wide as well for the region and overseas markets. It is apparently that the product is still very new to the majority general public (the middle and higher classes as well as low class).

However the current packaging materials are not well designed and accepted especially the labeling and in addition smoked dagaa products dealers have no legal licence for dealing with smoked dagaa products. Production of big quantities is big challenges for the processors to be able to penetrate regional and overseas markets they have to produces in terms of tones. Of which a single person or family is a laborious to make at

least 1 tone of smoked dagaa in one month. However if some groups from a formal established association can jointly make it can be able to full fill an order of at minimum of 10 tones for defined period say one in monthly basis for export market.

PROSPECTS ON HOT SMOKED DAGAA

Smoked dagaa products have big prospects in future markets following depleting of wild Nile perch and other commercial fish species while dagaa biomass is reported by TAFIRI (IFMP Regional Hydro-acoustic Working Group from 1999 to 2008) to be increasing. This implies that dagaa and dagaa products may become a leading fishery production in the Lake Victoria. At present dagaa products are the most spread fishery products which have been consumed by majority in the country and regional markets. However export is hampered due to uncontrolled border trade and also because of existing poor, unhygienic handling and processing of dagaa products. Following improved handling and processing dagaa products may increase export, foreign exchange gains as well as increase its shelf life. Example for the smoked dagaa which are stored at room temperature is estimated to be more than 12 months (Per. Obs.). More over, several brands of smoked dagaa products can be processed simply by applying different additives/ ingredients such as spices, salt, chilly etc. Smoked dagaa products can be milled and packaged in powder form to be used for human food fortifications.

REDUCING POST-HARVEST LOSS OF DAGAA

Fish post harvest losses include physical loss from poor handling and preservation; economic loss when spoilage occurs or when higher costs are incurred in reprocessing dagaa; and nutritional loss when dagaa is unsafe to eat. In addition there is house hold/consumer post harvest loss for dagaa products, where by during preparation majority they remove heads and treat as waste. Also due to poor safety measures, large quantities of dagaa are processed into fish meal for feed when they could have been better used for human food. Nearly 10 percent (13 million metric tons) of the world's total fish production is lost as a result of spoilage (3). Considering the high global demand for fish and scarce natural resources, this waste alone justifies efforts to improve quality and safety in the fish trade. Through improving hot smoked Lake Victoria dagaa products will reduce post harvest compared to customarily tradition sun dried dagaa which deteriorate through oxidation and infestations by rodents and insects due to the unhygienic marketing and storage environments found in the domestic markets. Because of high quality of smoked dagaa compile the hygienic environment for storage and selling. This further enables hygienic handling during trading. If smoked dagaa and dagaa products are properly and hygienically handled extends shelf life. This implies that dagaa can be processed as much as investments allow.

DISCUSSION

Preservation of dagaa and dagaa products by hot smoking technique here under referred as modified altona (Nyegezi oven) is highly preferred modern technique which now has spreade around the Lake Victoria Tanzania side. Although the market for ready to eat hot smoked dagaa and dagaa products, is not well advertised as compared to customarily sun dried dagaa. There is still high demand and bright future market for these products which has more advantages than disadvantages in terms of long shelf life, flavour, and increased acceptability and utilization of dagaa, in terms of quality and safety to consumers. Smoked dagaa products can be spiced with different types of spices like chilly, salt and other spices as the customer will require. Smoked dagaa products can be milled and packaged in powder form to be used for human foods fortification. The study on spiced smoked dagaa, found that there were no dirt or filth content that was found in smoked dagaa products compared to customarily tradition sun dried dagaa products (4). The normal silvery colour was changed to golden or brownish colour which increased taste, flovour and acceptability to the consumers. These results were obtained from the general dagaa consumers at the open market. Consumers taste was 100% accepted and as well as price was accepted and affordable. However in order to maintain high quality of smoked dagaa, there is a need to introduce durable primary and secondary packaging materials which will ensure high quality. Dagaa and dagaa product may enter regional and or even to the overseas markets if the stringent conditions on safety and quality of products in the cross border trade will be fulfilled. Because of its long shelf life and good quality and safety that meet requirements for export markets may finally compete very well in all domestic, regional and overseas.

CONCLUSION AND RECOMMENDATIONS

There are many challenges to be encountered on hot smoked dagaa and dagaa products because of dependence on weather availability of sun light, use of fire wood, difficulties in business or market accessibility and awareness rising to the general public consumers. In the present smoking it was learned to be insignificant to raise enough volume for export quantities to at least 10 tones. Alternatively hot smoking of dagaa has to be thought for, so as to minimize dependent of single source of fuel i.e. Fire woods. Chilling and Freezing preservation techniques have to be practiced so as to enable significant volume for export to distant markets which demand such a big export volume. Provision of chilling and freezing facilities will significantly reduce post harvest losses of dagaa.

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**APPENDIX I: QUESTIONNAIRE FOR HOT SMOKED LAKE VICTORIA
SARDINE (*Rastrineobola argentea*) FOR HUMAN CONSUMPTION.**

Date:

Contact Person Name and address:

Phone:

E-mail:

1. What types of fishery do you trade?
2. What types of fishery do you consume?
3. If the answer is not Daga products. Would you be interested to trade in Daga products? YES NO
4. Which kind of Daga product you would be interested in? Smoked.....Sun dried or Fried
5. Have you tasted smoked Daga products? YES NO
6. If the answer above is yes; did you like them? YES NO
7. How do you like the general appearance?.....
Which price would you be acceptable for this daga product per /package?
TZS 500/40gm.....; TZS 800/60gm.....; TZS 1000/100gm.....;
TZS 2000/200gm; TZS 2500/250gm..... and TZS 8000/ 1kg.....
8. What quantity would you think is affordable for smoked Daga packages? Which quantity per annum could you buy and for which product?
9. Would you be interested in organic certification? YES NO
10. Would you agree to pay premium for a certified Daga product? YES NO
11. If the answer above is yes. Which kind of product are the possible competitors of Daga?
12. What do you think about smoked Daga trade?
13. Are you interest in smoked Daga product?
14. What are your general comments about smoked Daga product?

APPENDIX II: SUMMERY OF QUESTIONNAIRE RESULTS

QUESTIONS	CRITERIA	RESPONDENT	PERCENTAGE
1	DAGAA	9	36
	OTHERS	15	60
	N/A	1	4
2	DAGAA	17	68
	OTHERS	19	76
3	YES	20	80
	NO	5	20
4	SD	17	68
	SDD	8	32
5	YES	25	100
	NO	0	0
6	YES	25	100
	NO	0	0
7	ATTARCTIVE	23	92
	NO	2	8
7B	40GM	3	12
	60GM	1	4
	100GM	11	44
	200GM	6	24
	250GM	2	8
	1000GM	1	4
8	<100KG	15	60
	>100KG	6	24
	>1000KG	4	16
9	YES	21	84
	NO	4	16
10	YES	21	84
	NO	4	16
11	BEEF	1	4
	CHICKEN	1	4
	FISH	12	48
	G. VEGETABLES	4	16
	NO	7	28
12	POSITIVE	16	64
	NEGATIVE	9	36
13	YES	24	96
	NO	1	4
14	POSITIVE	22	88
	NEGATIVE	3	12

Legend: SD: Smoked Dagaa; SDD: Sun Dried Dagaa