PROLONGING FRESHNESS OF TILAPIA *Oreochromis niloticus* BY EVAPORATIVE COOLING SYSTEM (ECS)

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ABSTRACT

The traditional practice of fish handling by fishermen and fishmongers, which gives room for early spoilage, was highlighted. The principle of Evaporative Cooling System (ECS) was adopted to construct a Wooden Evaporative Coolant Structure (WECS) to prolong the freshness of Tilapia, *Oreochromis niloticus*. The keeping quality of the two structures was compared with fish kept at ambient using temperature, relative humidity, weight loss and organoleptic indices. Results showed that the Basket ESC and Wooden ECS recorded lower temperatures and higher relative humidity values as compared with the ambient. Tilapia stored at ambient condition recorded significantly higher weight loss ($P>0.05$) than those kept in BECS and WECS. Results of sensory evaluation showed that there was a gradual reduction in the organoleptic quality of the fish stored in BECS and WECS. Quality of whole fish by panelist after 8 hours of storage showed that the two ECS models recorded significantly higher ($P<0.05$) freshness scores than fish stored at ambient temperature. It is therefore recommended that fishmongers should adopt this technology (BECS and WECS) as a means of prolonging the freshness of Tilapia Oreochromis *niloticus* before they are sold to consumers.

Keywords: Evaporative Cooling System (ECS), Wooden Evaporative Cooling System (WES), Basket Evaporative Cooling System (BECS), Keeping Quality and Spoilage.

INTRODUCTION

Fish spoilage is a common phenomenon in the Artisanal fishery sector. This is because the traditional practice of fish handling precipitates the activity of bacteria and autolysis. The scenario is such that fishing trips around to lake basin last between 4-7 hours (Ogal, 1995) and at harvest, fishermen leave fish at the bottom of their canoes, often in dirty water while fishing lasted (Eyo, 1977). On arrival at the beach, fish are sorted on bare ground according to their freshness and sold to fishmongers who keep all fish purchased under a shade pending collection of enough fish for sales.

Cooling fish with ice (Amos, 1981) is the best-known method of fish preservation (Ogali and Adelowo, 1995). This fact is well known among artisanal fisherfolk in Nigeria who are aware of the benefit of ice but due to lack of electricity in most fishing villages, the conventional refrigeration are not accessible. Furthermore, the cost of processing ice is exorbitant couple with the fact that the fishermen use dug out canoes, which do not have space for keeping ice during fishing trips. The design of the canoe is such that it is an open structure that exposes ice to high ambient temperature of the tropics, which melts the ice easily. The duration of the fishing trip is another factor that militates against the use of ice.

The cooling system described in this study is the principle of evaporative cooling whereby a liquid is converted to vapor; heat is absorbed from the fish. This heat is the latent heat used in causing the transformation from liquid to vapor(Okeke et al, 1990). The absorption of this latent heat from the fish brings about a fall in its temperature. The faster the evaporation, the greater is the fall in temperature. Thus in dry hot or windy days the fall in the temperature of the fish due to evaporation is greater than in moist, cold still day.

Evaporative cooling is a possible means of extending the freshness of fish Cluscas and Sutcliffe, 1981; Ogali and Adelowo, 1995), however the use of ice is always recommended. In Nigeria where the use of ice is impracticable, any measure that can extend the freshness of fish is a welcome development especially if it is affordable by the fishmongers. This will substantially improve the social and economic status of the fisher folks.

The evaporative coolant structures described in this study were designed as cooling chambers to lower the temperature of the fish relative to the ambient temperature therebykeeping the freshness of the fish. It is suitable for retaining the freshness of the fish during fish trips by fishermen, enhances sales of fish by fishmongers and cheap to construct.

MATERIALS AND METHODS

Basket Evaporative Coolant Structure (BECS).

A basket evaporative coolant structure (BECS) consists of an open basket of dimension 40cm perimeters (fig. 1). Wet sawdust of 2cm thickness was stuffed inside the basket and polythene sack was spread over it. Another polythene sack was also used to cover the top of the fish. A minimum and maximum thermometer and a hair hygrometer were provided in the BECS for temperature and relative humidity measurements. The top sack was watered at 6.00 am, 2.00 noon and 6.00 p.m. The weight of each fish in the BECS and the ambient were recorded every two hours of the same day.

Wooden Evaporative Coolant Structure (WECS).

A rectangular coolant structure consists of an open wooden box dimension 75cm x 40cm x 30cm and 2cm thickness was constructed locally (fig. 2). Six bottom drain holes were provided at the base of the structure to allow percolation of excess water outside the structure. The bottom of the structure was lined with wet thick 2cm sawdust. A layer of moist polythene sack was laid inside the box while a second one on top of the fish. A minimum and maximum thermometer and a hair hygrometer were provided in WECS for temperature and humidity measurements. Moistening of the top sack was done at 6.00 am, 10.00 am, 2.00 noon and 6.00 p.m.

Storage of Fish

The fish for the study was *Oreochromis niloticus* purchased from fishermen at the Kainji dam site. Fish were delivered at the experimental site at 7.00 a.m. being an average of 30 minutes after capture. Zero time was taken at the time of arrival at the experimental site.

Fish were cleaned and eviscerated under running tap water. One third of the fish, which served as control was kept under a shade at ambient condition. The remaining fish was kept in the WECS and BECS. Ten fish constituted a treatment and the storage was repeated two times for *O. niloticus*. Minimum and maximum temperatures and relative humidity of the WECS and BECS and the ambient were recorded daily with the aid of minimum and maximum thermometer and hair hygrometer for one week. The weight of each fish in the ECS models and the ambient respectively were recorded every 2 hours until 7.00 p.m. of the same day.

Organoleptic Assessment

A 10 untrained panelist examined each fish from the two models and the ambient for quality deterioration at zero hour and an interval of 2 hours. The appearance of the eyes, skin, the color and odor of the gills and the firmness of the flesh were graded using a ten-point freshness score. After 8 hours of storage the quality of the whole fish was judged by the same panelists who were asked to score for appearance, texture, odor and overall acceptability of the product on a hedonic scale of 9-1 indicating decreasing quality of the fish.

Taste Panel Assessment

Ten fish each from WECS and BECS weighing approximately 30g were cooked in boiling water. Samples from the ambient could not be cooked because the fish flesh has deteriorated. The same panelist was asked to score for color, odor, aroma, taste and general acceptability of the fish. A hedonic scale of 9-1 indicting decreasing quality was used.

Statistical Analysis.

Comparison of the treatment was analyzed by one-way Analysis of Variance (ANOVA) and Duncan's multiple range test.

RESULTS AND DISCUSSION

Physical examination of Tilapia at zero time is presented in table 1. Parameters observed were the general conditions of the eyes, gills, scale and odor before the experiment commenced. Generally the conditions of all the parameters observed were excellent indicating that Tilapia was in its fresh state.

The basket and wooden ECS recorded lower temperatures and higher relative humidity values as compare with the ambient. The basket ECS gave a temperature drop of 4.5°C and a relative humidity elevation of 36.8% while the wooden ECS gave a temperature differential of 3.5°C and relative humidity elevation of 37.6% compared with the ambient value (Table 2). Both ECS models provided better air-cooling and humidifying effects than the ambient. Tilapia stored at ambient condition recorded significantly higher weight losses ($P<0.05$) than those kept in the Basket and wooden ECS respectively. Table 3 shows cumulative percentage hourly weight loss of Tilapia (*Oreochromis niloticus*) stored in Basket (ECS), wooden ECS and ambient. The result shows a decrease in the weight of BECS, WECS and ambient respectively. However there was no significant difference ($P> 0.05$) between weight loss in BECS and WECS but there was significant difference ($P<0.05$) in the weight loss of the ambient when compared with BECS and WECS. The reduced weight loss in fish stored in BECS and WECS is attributed to the higher relative humidity maintained in the two storage chambers. The result ant effect is that fish maintained their fresh appearance for a much longer period than those stored at ambient (Ogali and Adelowo 1995).

The result of the sensory examination showed that there was a gradual reduction in the organoleptic quality of the fish stored in the Basket ECS, Wooden ECS and the ambient (Table 4). Quality assessment of whole fish by panelist after 8 hours storage showed that the two ECS models recorded significantly higher ($P<0.05$) freshness scores than fish stored at ambient (Gorga, 1988). All fish stored in the basket and wooden ECS retained their fresh appearance while the surface of fish stored at ambient became dry and lost their moist and attractive appearance. Infestation by flies during storage at ambient and the subsequent laying of large numbers of eggs in fish mouth, gills and skin lead to their total loss of appeal (Ogali and Adelowo, 1995). There was no significant difference ($P>0.05$) between the freshness scores of fish stored in the basket and wooden ECS.

Table 5 shows the physical examination of the 3 treatments after 8 hours of storage. The results for both BECS and WECS showed that the eyes were bright and flat, gills dull red, scales loosen under pressure and neutral odor. Conversely, the result of the ambient was the reverse.

The observed parameters in BECS and WESCS were acceptable because of the treatment they were subjected to while that of the ambient was objectionable because it was not treated but was left at the mercy of the environment.

Taste panel results indicate that losses of freshness occurred more rapidly in fish store at ambient condition than in the basket and wooden ECS. Taste and aroma scores for fish stored in the basket and Wooden ECS were significantly higher ($P<0.05$) than fish stored at ambient. There was no significant difference ($P>0.05$) between the freshness scores of fish stored in the Basket and Wooden ECS.

the higher relative humidity maintained inside the two storage chambers. The resultant effect is that fish maintained their freshness appearance for a much longer period than those stored at

Table 1: Physical examination of Tilapia at Zero time prior to the treatment.

PARAMETERS	BECS	WECS	AMBIENT
EYES	EBF	EBF	EBF
GILLS	GBR	GBR	EBF
SCALE	FA	FA	FA
ODOUR	FO	FO	FO

EBF - Eyes Bright and Full
GBR - Gills Bright Red
SFA - Scale Firmly Attached
FO - Fresh Odor

Table 2: Mean temperature and relative humidity measurement in wooden and basket evaporative coolant structure (ECS) and Ambient over a period of one week.

ECS models	TEMPEATURE ^{0}C			RELTIVE HUMIDITY %	
	Mean initial T° of fish when stacked	Mean final T° fish after treatment	Differential	Mean	Differential
Basket ECS	32.00	27.5	4.5	91.3	36.8
Wooden ECS	33.00	29.50	3.5	93.7	37.6
*Ambient	33.40	45.50	12.10	57.3	1.02

*Rise in temperature compare with BECS and WECS that had a drop in temperature.

Table 3: Accumulative percentage hourly weight loss of Tilapia (*Oreochromis niloticus*) stored in Basket ECS and Wooden ECS and Ambient.

Hours after storag4e	Basket ECS	Wooden ECS	Ambient
2	1.28	1.29	3.85
4	1.69	1.39	6.52
6	2.26	2.20	14.0
8	2.7	2.60	15.20

Treatment means L.S.D. = 6.38 at 5% level.

Table 4: Assessment of freshness of raw Tilapia by panelist after 8 hours storage in Basket ECS, Wooden ECS and Ambient.

Oranoleptic property	Basket ECS (%)	Wooden ECS (%)	Ambient (%)
Appearance	68	58	26
Texture	74	60	32
Odor	60	54	30

Treatment means L.S.D. = 7.9 at 5% level.

Table 5: Physical examination of *Tilapia, Oreochromis niloticus* after 8 hours of storage.

PARAMETERS	BECS	WECS	AMBIENT
EYES	EBF	EBF	EDS
GILLS	ED	ED	GGA
SCALE	SLSP	SLSP	SVL
ODOUR	NO	NO	OVA

KEY

EBF - Eyes Bright Ad Full
EDS - Eyes dull and sunken
GDR - gills dull red
GGA - Gills Grey Amonical
SLSP - scale loose under slight pressure
SVL - Scale very loose
OVA - Odor very amonical
NO - Neutral odour

Table 6. Organoleptic Scores for BECS, WECS and Ambients

Organoletpic	TOTAL SCORES		
	Basket ECS	Wooden ECS	Ambients
Taste	4.40	3.90	2.7
Aroma	4.50	4.10	3.1
Mean	4.45	4.00	2.9

CONCLUSION

The effect of evaporative cooling in extending the freshness of fish has been established in this study. The reduced weight loss in fish stored in Basket and Wooden ECS is attributed to the higher relative humidity maintained inside the two storage chambers. The resultant effect is that fish maintained their freshness appearance for a much longer period than those stored at ambient. The lower relative humidity of the ambient probably resulted to the higher moisture loss and dry surface of fish skin, which cause their total loss of appeal.

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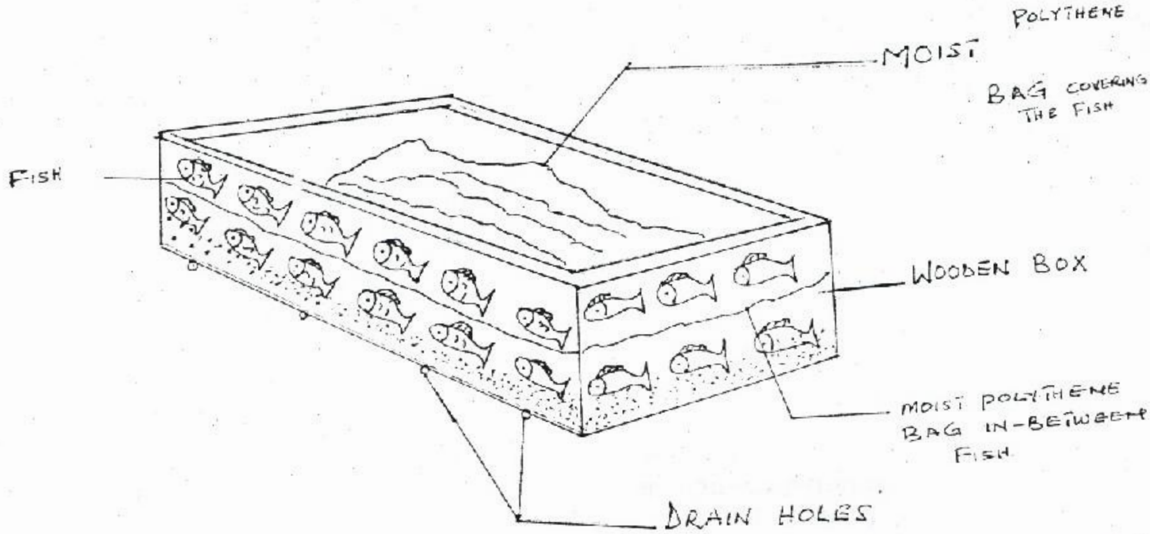

Fig 2: WOODEN EVAPORATIVE COOLANT STRUCTURE (WECS)