The Gjerstad Kiln: A Combined Hot and Cold Smoking Kiln

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A combined hot and cold smoking kiln has been constructed for use at Lake Turkana, Kenya. Used for cold smoking, the kiln's main advantages over the traditional kilns used in this area are its greater smoking capacity and lower firewood consumption. Having the option of using the same smoke house for cold and hot smoking reduces the total construction costs for an operator producing both types of smoke cured product. The hot smoking process was found to require markedly less firewood than cold smoking, a fact of considerable importance in desert or semi-desert areas with sparse vegetation.

During the last twenty years several studies have been made to introduce improved smoking kilns to replace traditional kilns in the tropics. This is aimed at making processing method more efficient by designing smoking facilities that can smoke larger quantities of fish than is possible by the older methods. Often a kiln design will prove its usefulness in other areas than that in which it was first constructed. An example of this is the kiln originally designed for Zambian conditions by Cabrita & Watanabe (1971) and later exported to Volta Lake (Watanabe 1974). In some cases, however, it is felt that the conditions pertaining to an area are so specific that such transfer of technology is not feasible without alterations being made in the original design. The kiln presented here is constructed for use in one such area, namely, the arid semi-desert Turkana District of Kenya. The scarcity of wood as a source of heat and smoke is felt here. This will be a central theme in this presentation. Furthermore I want to focus on differences and limitations of hot and cold smoking respectively.

Fish from Lake Turkana is smoked in traditional kilns erected close to the shores of the lake. This reduces transportation time and costs from when the fish is landed till it is smoked, ensuring excellent raw material. The kilns used by artisanal fishermen and fish mongers are rectangular structures made of mud. The four walls, approximately 1 m high, enclose the smoke producing material. Heat and smoke is produced by burning scraps of shells from Doum palm nuts. These scraps are strewn on the sand floor of the kiln in a 2–5 cm layer. A wiremesh tray of the shape of the rectangular kiln is placed on the mud walls so that the top is completely covered. Fish is then laid out on the wire-mesh. To prevent the smoke from leaving the kiln too rapidly the fish are covered by sisal mats.

Only two types of fish are smoked using this traditional method, chubule *(Labeo horie)* and *Tilapia (Sarotherodon galilaeus)* and *(Oreochromis nilotica)*. The fish are not salted before smoking. The smoking process described is cold smoking, and the product has its market outside the Turkana district.

A problem in this semi-desert area is the lack of trees. Traditionally the Turkana tribesmen are pastoral nomads. Small stock and camels browse on the scarce vegetation, which is also used for building homesteads and for firewood. Deforestation in the areas close to the lack shore leads to soil erosion. Along the shore one also finds the stately Doum palm tree, with its partly

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Table 1. *Construction costs for the Gjerstad combined hot and cold smoking kiln (One Kenya shilling (Ksh.)* = 0.1 US $

Item	Dimens./Quantity req.	Unit price (Ksh)	Calc. cost (Ksh.)
2½ x 5" bricks	1800	0.75	1350
6 mm steel sheet (door)	70 x 110 cm	600/m²	462
6 mm steel sheet (floor)	150 x 150 cm	600 ,,	1350
Corrugated sheet (roof)	170 x 160 cm	75 ,,	204
Pipe connecting kiln	300 cm	150/m	450
Mesh wire 4 frames	150 x 150 cm	25/m²	225
Timber for 4 frames	24 run. m	8/m	192
Timber for roof support	10 x 5 x 300 cm	20/m	60
Cement	200 kg	1.50/kg	300
		Material cost =	4401 Ksh

edible fruit. Stems of Doum palm are used by the fishermen to build rafts. As long as only the scraps of shells from Doum palm are used for smoking, this processing method in itself is not considered as representing any threat to the vegetation.

Materials and Methods

The kiln is presented in Fig. 1. It has a capacity for hot smoking 75–100 kg of fish for 2 h, and cold smoking the same amount of fish for 14–18 h. When using the kiln for hot smoking scraps of shells from Doum palm nuts provide heat while sawdust, which is strewn on a steel sheet, produces

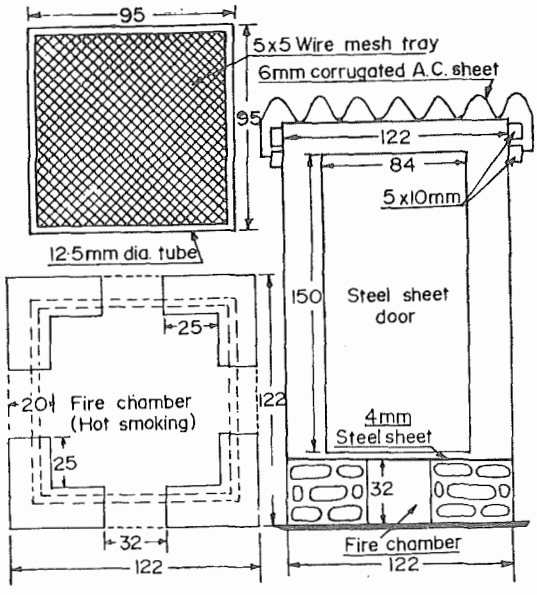

Fig. 1. The Gjerstad kiln (front view)

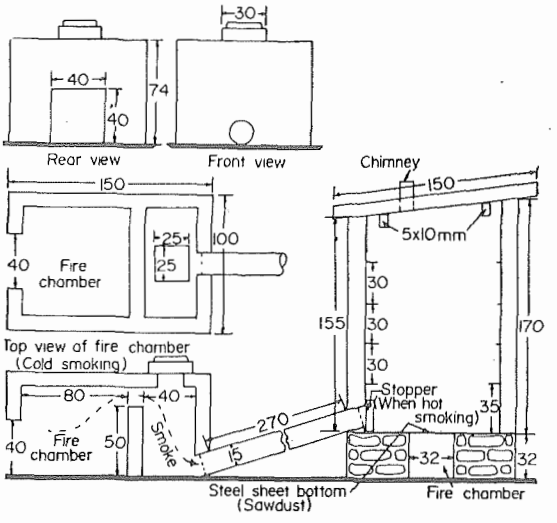

Fig. 2. The Gjerstad kiln (side view)

smoke. As a cold smoking kiln only sawdust is required, but then considerably larger quantities are used.

The fact that both cost and heat loss is high in all steel kilns was pointed out by Rogers (1970), who used cement blocks instead of steel sheet as construction material to improve a Ugandan kiln type already in use. One of the aims of this improvement was to reduce firewood consumption. The combined hot and cold smoking kiln presented here is made of bricks which give a minimal heat loss and are readily available.

When used for cold-smoking, tilapia and chubule are prepared in the same way as for the traditional smoking method.

When hot smoking tilapia and chubule the fish must hang otherwise will drop on the floor during processing and get spoiled. The fish in this trial was filled as for cold smoking and kept whole gutted as for hot smoking. It was salted prior to processing in a brine or by dry salting. A 10% salt solution was used for the brine. For dry salting 40 g of salt was used per kilo of fish. The relative low salt concentration chosen here compared to other areas was directly linked to a marketing survey showing a consumer preference for slightly salted products. Dry salting took 48 h and brine salting took 24 h.

The fish was washed in water of drinking quality before smoking. With respect to cold smoking the fish was cut into 2–3 cm thick fillets. Blood, bones etc. were removed before salting and smoking.

For each batch of fish that is hot smoked 400–600 g of sawdust is strewn inside on the steel bottom of the kiln. To keep the fire underneath the steel plate going for 2 h, 15 kg of Doum palm nutshell scraps is required. Cold smoking the same amount of fish requires 15 kg of sawdust placed in the smoke chamber.

Results and Discussion

The weight loss due to smoking (both hot and cold smoking) was 30% for chubule and 40% for tilapia. As a general rule the flesh from the hot smoked products is white, while that of the cold smoked products has a greyish to glassy appearance. This might be related to different types of protein denaturation taking place (i.e. mainly salt denaturation v.s. salt and heat denaturation). The surface colour varies from yellowish or golden for cold smoked tilapia to a more brownish colour for cold smoked chubule. In general one can say that the hot smoked product is slightly darker than its cold smoked counterpart for each of the two species. The trend is for the cold smoked products (in all cases) to have a more smoky flavour than the hot smoked ones.

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