Evaluation of the Smoked Machine with Dual Heating Sources

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***Abstract*— This paper presents a design for a smoked machine that combines an insulated chamber with a heating filament, blowers, and a biomass smoking furnace. A combination of energy sources from heating filament and wood which was fed into the furnace at predetermined amounts were utilized to achieve the desired temperature. Temperature and airflow velocity in the chamber of the machine were simulated to elucidate the behaviour of hot air flow and observed the temperature difference at every point in the machine. The finite element analyses showed that there was a stagnant air pocket in the upper rear region of the chamber due difference in pressure at the inlet and outlet. Therefore, the design was optimized, and a rotating tray design was proposed for the pilot test machine. Then, a pilot test was carried out to verify the proposed design. The pilot tests were conducted using banana fish, which is a type of Albula vulpes species, weighing from 0.3–0.4 kg/head. It was observed that the temperature of the smoking chamber varied from 85ºC and 115ºC. The results showed that the smoking system was able to perform the smoking process of the fish in 3 hours with 50% moisture reduction and no coliform or e-coli were found in the samples. Based on the test results, the dual heating smoking system developed and evaluated in this study is predicted to be able to complete the smoking process of the fish in 4-5 hours with 70% moisture reduction which complies with food safety regulations. In addition, it has the capacity to produce hygienic smoked fisheries.**

Keywords—smoked machine, smoked fish, heat exchanger temperature, moisture content, weight loss.

I. INTRODUCTION

Traditional methods of fisheries preservation include smoking, drying, marinating, and salting [1]. Existing smoked fisheries production facilities in Malaysia, particularly in Sarawak, are antiquated and inefficient, consisting largely of shacks. Bamboo or wire trays are placed on the floor over open fires or semi-open fires. A large quantity of mangrove-sourced fuel wood is utilised in the traditional smoking method. In the process, neither heat nor smoke are optimised. This poses a significant threat to mangroves because of overharvesting [2] and other commercial uses, such as a meat preservative [3].

The cottage industry for smoked fisheries strives to produce sustainable exclusive and premium products. This necessitates more hygienic procedures that adhere to food certification standards, especially for export markets. This will increase community income without compromising mangrove habitats further. Therefore, it is advantageous to have a smokehouse and stove that are fuel-efficient, eco-friendly, and hygienic. The final products may meet international quality standards and become more commercially viable [4].

Several researchers opt to dry the fisheries using a solar system [5]-[7]. The system may serve the machine's intended function of drying fisheries, but the smoke's odour cannot be retained. The smoke aroma of this product significantly contributes to its distinctive flavour and cannot be overlooked. The chamber-style smoking machines, on the other hand, use only wood and are essentially the same size [8]-[11]. They took approximately 4-5 hours to complete the process of reducing the water content to 10-25 % in accordance with the food safety requirement. Research have shown that, the moisture content and water activity must be kept below approximately 10 to avoid microbial growth [12]. Based on this review, it was identified that none of the systems use a hybrid heating source.

Therefore, it is necessary to investigate technology support that can help to improve smokehouses, reduce reliance on mangrove fuel wood, and still provide the community with long-term income benefits. In this paper, we proposed a compact, insulated machine with a simple control system that utilises a dual heating source consisting of a heater and smoke to preserve flavour and aroma. The design of the heating systems is modular. The temperature generated in the machine was supported by a heating filament with the blowers which channelled heat flow while the biomass smoking furnace channelled smoke-heat flow. The user can therefore choose between using either a heater or a heater and smoking.