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Localized coal-fired food dyer innovation: Its fabrication and utilization among small scale farmers and fisherfolks in Camiguin Island, the Philippines

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Abstract

The design, fabrication, construction and performance evaluation of a coal-fired food dryer using coal and wood fuel as a source of heat was undertaken to help small-scale farmer's process foods. The coal-fired food dryer was constructed out of welded galvanized iron pipe, metal, steel plate materials and consists of a burner (furnace), drying chamber, fan blower, drying trays, heating element, and body frame. The dryer was evaluated in terms of drying capacity, temperature range, time taken to dry the products, moisture and solid content, and the quality of the dried products. Its drying capacity is 20 kg. per drying load conducted with 3 trials on sliced fish, squid, and banana products with minimum and maximum drying temperature of 110 °F (43.33 °C) and 130 °F (54.44 °C), time taken for fish, squids and banana were 7-8 hours, 3 hours, and 4 hours respectively. This localized coal-fired food dryer is suitable for drying foods with content moisture of 40%-60%, 82%-18% and 47%-53%, respectively. Furthermore, the quality of fish, squid, and banana was found good based on the panel evaluator during the in-house presentation. In addition, dyer evaluation was assessed for small-scale drying of fishes, squids, and bananas in the local community. Thus, the study concluded that the locally fabricated coal-fired food dryer is effective and operational equipped for drying various foods at a specific temperature and number of hours.

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Introduction

Food preservation plays an important role in particular circumstances like this COVID-19 pandemic. First, it may stop the panic buying of storable consumer goods, a common phenomenon during natural disasters, man-made crises, or pandemics. Preserving foods enables you to create delicious, flavourful, and nutritious food at home that can be enjoyed year-round. More importantly, proper food preservations allow for fewer trips to the grocery store, therefore saving time, reducing food waste, and less time spent in public places during the COVID-19 pandemic (Eifert and Chase, 2020), food safety experts with Virginia Cooperative Extension.

Archaicly, drying is an ancient process used to preserve foods. Conventional drying (hot air) offers dehydrated products that can have an extended life of a year. Unfortunately, the quality of a conventionally dried product is drastically reduced from that of the original foodstuff (Ratti, 2001). Developing an efficient drying system with combined novel thermal and conventional hot-air drying of agricultural crops has become potentially a viable substitute for traditional drying techniques. Due to the synergistic effect, the total energy and time required can be drastically reduced, and the final quality of agricultural crops is preserved. The growing interest and research in recent years have already shown that novel thermal with hot-air drying technology can adequately be used in the drying of agricultural crops (Onwude, 2016). Considering the fish is easy to rot, and to provide added value to the fish results, it is necessary to improve current fish preservation methods and technology. In general, most of the fishers implement traditional technology passed through generations in processing and preserving fish called 'drying' as a process of removing a portion of water content from a specific material through evaporation of the water content using heat to achieve the desired moisture content. The drying process is known as an energy-intensive process, and in industry, the drying process consumes 10-25% of total energy consumption in developed countries (Majumdar and Law, 2010). Fishes are well known for their various nutritional compositions, approximately contains 70-84 % water, 15-24 % protein, 0.1-22% fat and 1-2%, minerals, 0.5% calcium, 0.25% phosphorus and 0.1% vitamins A, D, B and C. They have been widely used as one of the most important sources of animal protein and other nutrients for human health all over the world (Longwe, P., Fannuel, K., 2016). The high temperatures of the tropics enhance autolytic activity and bacterial growth and accelerate spoilage. The flying fish is considered a low-value fish in the Philippines but is a good source of inexpensive animal protein. The challenge is to effectively utilize this vulnerable, raw material to increase its market value. The study evaluated the physicochemical changes and sensory attributes of flying fish *(Cheilopogon intermedius)* fillets marinated in three different marinating solutions (marinade 1: ham flavour; marinade 2: salty-sour flavour; marinade 3: spiced flavour) (Simora, Armada and Babaran, 2021).

Processing can be defined as a method applied to the fish from harvest to the consumption period (Aberoumand, 2014). Taking note of the chemical composition, fish is highly perishable. Therefore, fish is highly susceptible to deterioration without processing or preservation measures (Holma and Ayinsa, 2013). The study of Omodara and Olanyan (2012) revealed that enzymes, bacteria and oxygen are the main responsible factors for several physiological and microbial deterioration set in and thereby degrade and spoil the fish and fish products. Fish start to spoil as soon as caught from the sea, 5 more over poor handling and preservation methods after capture increase its degree of spoilage. Holma *et al.* (2013) also stated in their studies that processing is essential to preserve fish both in quality and quantities in a good manner and helps to use in off-seasons when it is done in the right time and right way, whereby the availability of fish can be secured throughout the year. Among numerous available methods, open-air sun drying is the most preferred method in tropical countries, due to its affordability, especially for smallholder farmers in rural areas. However, the drying process dramatically relies on ambient conditions and is very prone to contamination by dust, rain, wind, pests, and rodents (Hage, Herez, Ramadan, Brazzi and Khaled, 2018; Singh, Shrivastava and Kumar, 2018), leading to low-quality products and a loss of farmers' income (Hage *et al.*, 2018).

Coal is the most widely used primary fuel for energy generation, but it emits toxic gasses after combustion. Whereas biomass is a renewable energy source and is used for environment-friendly energy production. Biomass does not add carbon dioxide to the atmosphere because it absorbs the same amount of carbon in growing as it releases when consumed as fuel. Generally, biomass used for co-firing with coal includes wood and woody wastes, municipal solid waste, animal wastes, agricultural crops and their waste by-products, waste from food processing, aquatic plants and algae.

The inherent moisture content in biomass decreases its heating value and it needs to be dried before using for co-firing. The drying of biomass could be performed in various types of dryers and all of them have their own merits and demerits. This paper provides a detail review on the need of drying biomass before co-firing, different technologies used for biomass drying, biomass co-firing to the existing coal-fired power plants and the environmental benefits of biomass co-firing (Vermaa, Amar, Pradip and Kumar, 2016)

At present, according to the fisher folks of Sitio Lagapak, Poblacion, Sagay, who was asking the institution for technical help, he said that they have an existing readymade food dryer which they bought by their cooperative, but unfortunately, after testing, they found out that it's not working and it was not effective and even spoiled their fish prepared for drying. He further added that they wanted to have an alternative drying process, especially during rainy seasons where traditional open sun drying is not applicable. To overcome their problem, researchers then come up with the idea of the study, which aims to design and fabricate a prototype coal-fired food dryer; as an innovation from a multipurpose fired mechanical dryer. It serves as an alternative solution in the drying process, specifically during the rainy season, by utilizing the woods debris' collected along the seashore and other agricultural residues like coconut husks/shells or rice hulls which are available in large quantities at no cost to energize the drying facility that can be used as fuel in the drying machine.

Materials and methods

Data gathering procedure

The researchers asked permission through a written letter to the Camiguin Polytechnic State College, College President Dr. Macario B. Oclarit. When the license was granted, the researchers then coordinated with the Institute of Technology faculty involved in the experimental or technological study. Researchers then started gathering different materials, tools, and resources needed to construct the fabrication of a coal-fired prototype food dryer. After finishing the food dryer, it has undergone testing and trial process and after testing its affectivity, it is now ready for drying a variety of foods at specific temperature and number of hours.

The study was presented during the in-house review for the completed research conducted by the college on February 23, 2021, at Multi-Media Center; after the presentation, it was then turned over and utilized by the fishermen / fisher folks beneficiaries at Sagay for the institution extension services.

After all, the study was conducted at Camiguin Polytechnic State College Balbagon, Mambajao, Camiguin. CPSC is a tertiary institution under the Commission on Higher Education (CHED). The school was founded in 1995 under RA 7923, authored by the late Congressman Pedro P. Romualdo.

Conceptualization

The study falls into the air and contact drying process categories where drying is under atmospheric pressure and heat is transferred through the foodstuff either from heated air or from heated surfaces. The water vapour is removed with the air.

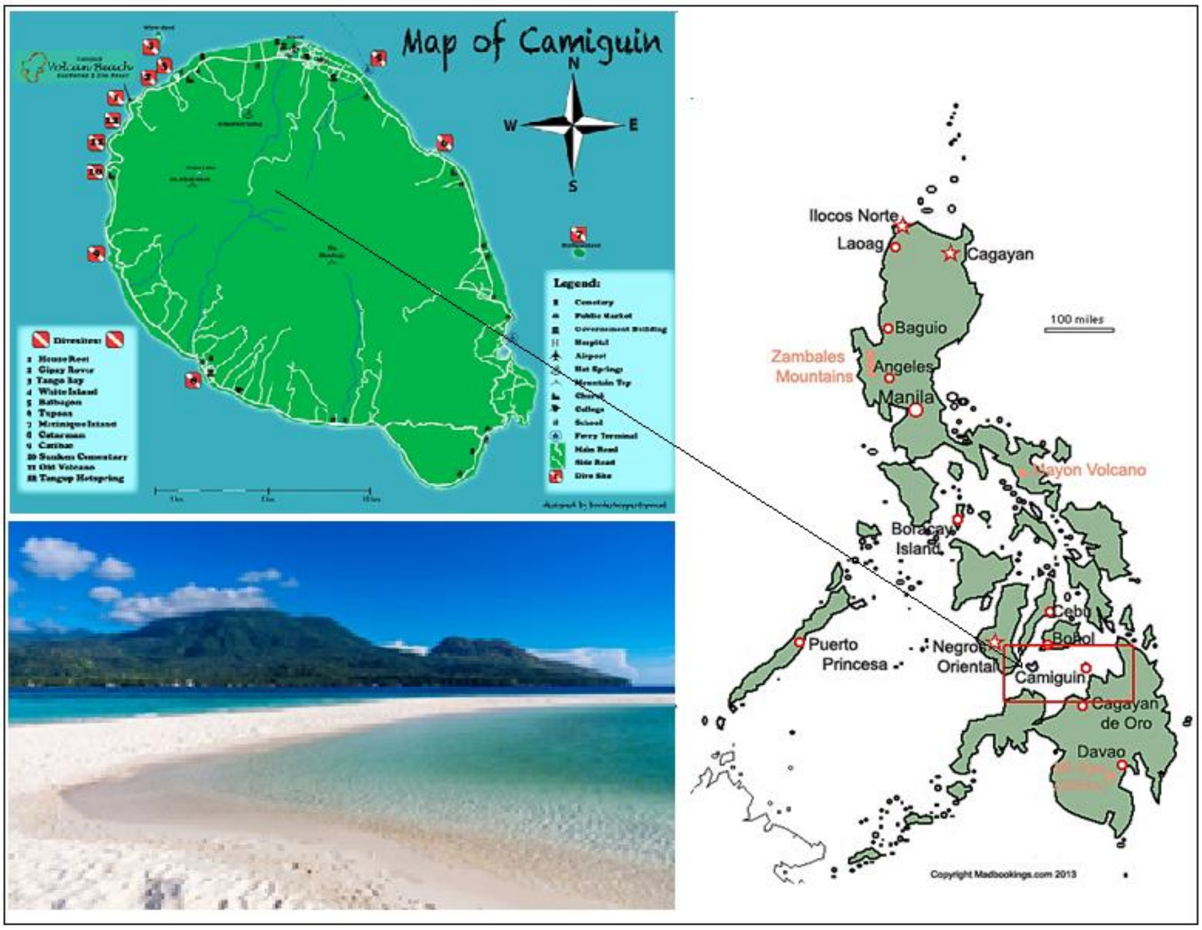

Fig. 1. Map of Camiguin Island, the Philippines.

The design fabricated prototype coal-fired food dryer was conceptualized to come up with alternative drying methods of different products, especially during rainy days. Though heat conduction energized by wooden debris is enough to dry fish, the idea of coal or wooden debris to provide a source of heat makes the dryer more functional during rainy seasons. The INPUT is the estimated dimensions, tools, shop equipment and facilities, the PROCESS is the construction of design, estimation and fabrication and the OUTPUT is the finished product of a fabricated coal-fired dryer made.

Design phase

The hot-air dryer is designed using locally available and recycled materials. These include galvanized metal sheets, stainless steel, galvanized iron pipe, aluminum trays, and more were obtained in the automotive shop and local markets. The device is designed to dry a variety of foods. It is made up of six main parts, namely, the burner (furnace), heating element, fan housing, aluminum trays, drying chamber, and a body (base) frame.

Dryer and its parts

The burner is one of the most important components of the design. The design uses iron steel cylindrical with dimensions; 1.91 cm thick, 21 cm in length, and 25 cm outside diameter. The furnace (burner) is installed permanently at one side of the body frame to provide heat to an interior space due to the burning of wood or coal material. Drying trays served to place or hold the food to dry, fabricated with aluminum angle bar and screen wire with the dimensions of ¾ in. × 27.5 in. × 28.5 in. fishes, squids, and fruits are spread for pre-treatment and handling during and after the process to prevent contamination. This is a removable drying tray for easy access for loading and unloading the fishes and other foods before, during, and after drying. The design uses galvanized iron steel with the dimensions of 4.00 in. in diameter and 36.0 in. length. It was placed at the outer top part of the furnace (burner), which is directly in contact with the flame by burning of wood in order to produce enough heat fan housing. In addition, this study uses a recycled auxiliary fan from the computer unit. Its primary purpose is to place at the inlet point of the heating element and effectively force ambient air across the heating element and at the same time expel moist air from the drying chamber. The body frame assembly is a fabricated; dryer dimensions are as follows: 3/8 in. thickness, 50 in. width, and 48 in. in height which is made of stainless steel sheet.

The frame assembly of the equipment encloses the entire parts of the design.

Supplementarily, Figures 3 and 4 show the schematic diagram of the prototype fabricated dryer and its furnace which shows the different parts such as: (a) burner / furnace, (b) fresh air, (c) wood fuel inlet, (d) fan, (e) heating element, (f) drying trays (aluminum), (g) moist air outlet, (h) circulated air, (i) drying chamber, and (j) stainless steel body frame that help to dry all types of agricultural products and marine products quickly. In addition, this prototype will also help clean the seashores in maximizing the usage of debris such as woods.

Fabrication and specification

The design was fabricated at the Institute of Technology, Automotive Shop, Camiguin Polytechnic State College, Balbagon, Mambajao, Camiguin Island last December 2020. Tools and equipment used were arc welding machine, grinder, metal cutter, and drill bit. Masonry tools were also used in installing the combustion chamber. The actual fabricated prototype machine and its specification are presented in Figure 2 and Table 1, which shows the overall appearance and interior view of the coal-fired food dryer, specifications, and applying the hot air drying of a cabinet / tray dryer method.

Dryer specification

Basic moisture and solid content calculation

These methods rely on measuring the mass of water in a known mass of the sample. The moisture content is determined by measuring the mass of food before and after the water is removed by evaporation.

$$\%Moisture = \frac{M_{INITIAL} - M_{DRIED}}{M_{INITIAL}} \times 100$$

Here, $M_{INITIAL}$ and M_{DRIED} are the mass of the sample before and after drying, respectively. The basic principle of this technique is that water has a lower boiling point than the other major components within foods, *e.g.,* lipids, proteins, carbohydrates and minerals. Sometimes a related parameter, known as the *total solids,* is reported as a measure of the moisture content. The entire solids content is a measure of the amount of material remaining after all the water has been evaporated. Thus, % total solids = (100 - % moisture). To obtain an accurate measurement of the moisture content or total solids of food using evaporation methods, it is necessary to remove all of the water molecules that were originally present in the food without changing the mass of the food matrix. This is often extremely difficult to achieve in practice because the high temperatures or long times required to remove all of the water molecules would lead to changes in the mass of the food matrix, *e.g.,* due to volatilization or chemical changes of some components. For this reason, the drying conditions used in evaporation methods are usually standardized in terms of temperature and time to obtain results as accurate and reproducible as possible, given the practical constraints. Using a standard method of sample preparation and analysis helps to minimize sample-to-sample variations within and between laboratories.

Utilization

The utilization of the heated-air drying method consists of placing the products in an enclosed cabinet type drying chamber where air entering is uncontrolled depending on the kind of source of heat to the desired temperature, humidity and velocity by artificial means. This type of uncontrolled atmosphere drying relies on the utilization of coal and wood debris found around the school vicinity or other biomass/agro-wastes as the energy source may also be utilized. Therefore, it does not encounter the problems associated with outdoor sun drying.

The locally fabricated prototype coal-fired food dryer was tested using coal and wood debris as the source of heat. Coal and woods were burnt in a constructed furnace that heated air in a heat exchanger.

An electric blower sucked the heated air and blew it into the drying chamber. Drying rate depends on the weather, temperature, speed of air movement and relative humidity of the air, kinds of foods to be dried, moisture and solid content of foods, fat content, size of fish or foods and whether sliced or not. On an hourly basis, the temperature was recorded, which ranges from a minimum of 110 °F to a maximum temperature of 140 °F during preheating. Sliced fish, squids and bananas were tested during the utilization of the locally fabricated coal-fired food dryer.

Evaluation and testing

After the fabrication, the dryer was preliminarily tested to determine the errors and problems that might be encountered during the final testing. The following data was collected during the test:

Temperature. During testing, the temperature was checked every 1 hour. A thermometer gauge was placed outside the chamber to monitor the temperature in order to control the feeding of fuel.

Weight of dried fish. A weighing scale was used to weigh the fish before and after drying and its weight should be checked every hour to determine the moisture content. The total weight per batch was recorded in Table 2.

The performance of the dryer was evaluated in terms of final fabricated dying capacity, temperature rate, moisture and solid content of dried products and time taken to dry the fish, squids and banana, the quality of the dried products was also considered.

Results and discussion

The fabricated coal-fired dryer components were measured, welded, riveted and assembled.

The dryer was test run to see its effect in all necessary adjustments, alignment, material selection, etc., where required. A portable cabinet, steel-fabricated, agro-waste fuelled by coconut husk, fuel woods or charcoal, was designed and tested based on the principle of air and contact drying process categories where drying is under atmospheric pressure, and heat is transferred through the foodstuff either from heated air or from heated surfaces, using biomass (coconut husks, firewood's or rice hulls) as the energy source, then water vapour is removed with the air.

Table 1. Items and specifications of fabricated coal-fired food dryer.

Items / Materials	Specifications
Metal box size	with dimensions of 3/8in.thickness, 50in., 30in.width, and 48 inches in height
Furnace size	1.91cm thick, × 21cm in length × 25cm outside diameter
Tray size	with dimensions of 3/4in. × 27.5in. × 28.5in. (10 pcs.)
Blower motor	DCV. 12 volts
Thermometer Gauge	DCV. 12 volts
Battery	12 volts 13 plates
Coal material	1 sack

Without load testing

A no-load test was conducted for the thermal condition which could be suitable for fish, fruits, and vegetable drying. This is important in order to determine the maximum temperature it would generate and also the time it would take to reach these temperatures. This idea was borne out of minimum and maximum drying temperatures 110 °F (43.33 °C) and 130 °F (54.44 °C), respectively, considered suitable for fish and other varieties of food drying. Figure 5 indicates temperature reading directly proportional to the time elapsed meaning, as the time increases, the temperature reading scale also increases.

Table 2. Weight summary of raw and dried products and it's moisture and total solid content.

Product	Raw	Dried	% Moisture	% Total Solid
Fish *(C. oxycephalus)*	2 kg.	1.2 kg.	40	60
Fish *(C. oxycephalus)*	4 kg.	2.2 kg	45	55
Squid *(Teuthida)*	1.5 kg.	271 kg.	81.933	18.067
Banana *(Musa acuminate)*	3 kg.	1.6 kg.	46.67	53.33

The same study was conducted by Dzivama and Liberty (2013) revealed that the design, construction, and performance evaluation of a cassava chips dryer using fuelwood as a source of heat was undertaken with a view to helping small scale farmers' process cassava chips. The dryer consists of a frame, drying chamber, a tray, fuelwood housing, perforated air space and a chimney.

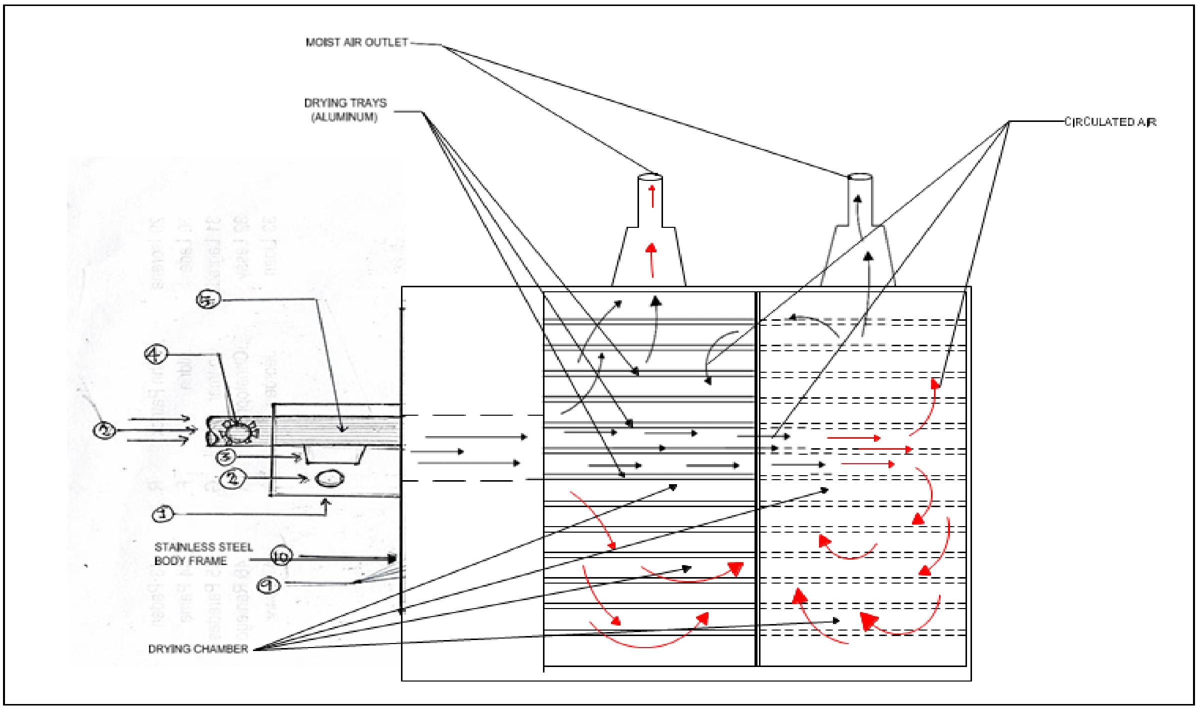

Fig. 2. Workflow of the prototype coal-fired dryer.

The dryer was evaluated in terms of final moisture content, drying capacity, time is taken to dry the chips and the quality of the chips. Results showed that the moisture content of 65.03% was reduced to 13.11%; the drying capacity was 6 kg per loading and the drying time, which was supposed to be 3 hours, was increased to 4hrs due to difficulty in regulating the heat produced by the fuel wood. Compared to other types of dryers (solar dryer, platform dryer, flat-bed dryer, continuous dryer, and more), the batch-type dryer is preferred due to its ability to be used during the rainy season and in the absence of electricity. The quality of the chips was found to be good. The dryer has an efficiency of 80%. Figure 6 below described the increasing heat temperature during the first test, the preheating test. The chamber for drying food during this time was empty. It was observed that there was an increase in temperature every hour from 100 °F to 140 °F for four hours. It was noted during the focus group discussion from the fisher folks that they need a temperature of 104 °F for them to dry their squid product.

With load testing

The 2.0 kg of fish was tested and evaluated in terms of its temperature difference and the time of operations in two different settings. The average temperature obtained by the dryer was maintained under 110 °F and 130 °F. As shown in Fig. 7 below, it indicates that the temperature reading scale was able to be obtained and regulated under normal operating conditions as expected. The dryer reported that temperatures ranging from 110 °F-130 °F were reached the time depends on the type of foods to be dried put in the trays inside the cabinet dryers chambers. The drying capacity was 20 kg. of fish, depending on the size of the fish and other foods. As seen in Figure 7 along the blue line is the first trial which describes the increase of temperature of 90 °F from the 8:30 in the morning to 9:30, an increase of 20 °F from 9:30 to 10:30 in the morning and an increase of 20 °F from 10:30 to 11:30 and decreases 10 °F from 11:30 to 12:30 in the afternoon. During this test, there were already two kilos of flying fish (*C. oxycephalus*) sliced for drying. The test lasted for four hours and the fish result was still half-dried.

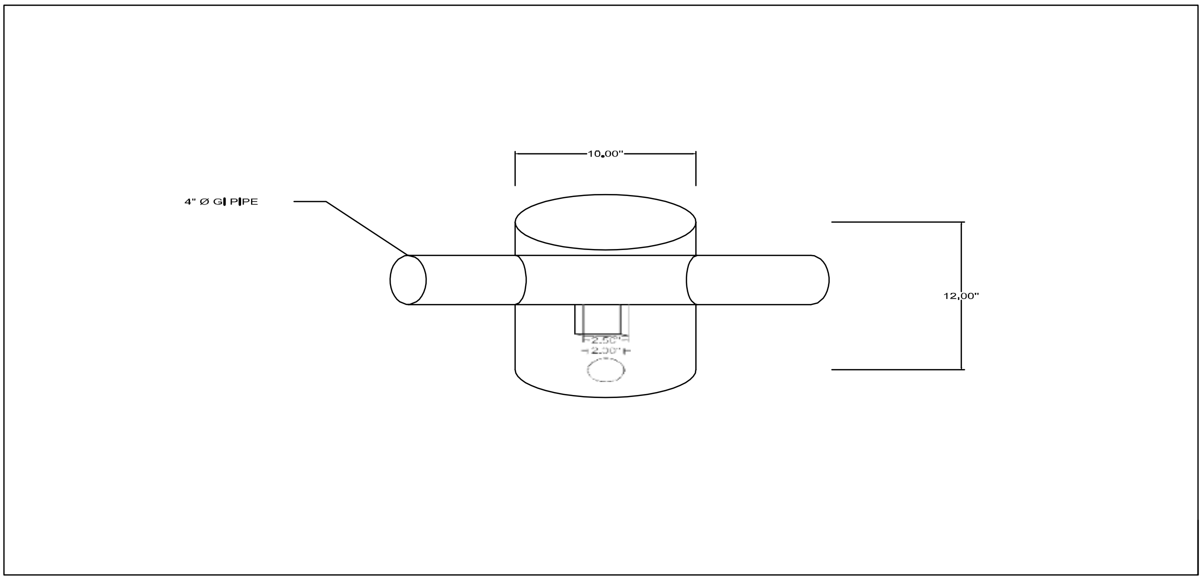

Fig. 3. Workflow of the furnace (burner).

Since the product is still half cook in order to obtain the desired dried fish output, Figure 7 along red line views the continuation of the drying process and described the increase of temperature of 100 °F within 1 hour from 8:30 to 09:30 a.m. an increase of 20 °F from 9:30 to 10:30 a.m., an increase of 10 °F from 10:30 to 11:30 a.m. in and gradually decreasing a 20 °F from 11:30 to 12:30 noontime.

The gradual decrease of temperature is evident due to no additional wood fuel added in the heating chamber of the prototype. On the other hand, flying fish *(C. oxycephalus)* or locally known as "bangsi" is among the most dominant catches in some areas in the Philippines like the western portion of Verde Island passages in the West Philippine Sea and around the Camotes Sea in the Visayan Seas (Dalzell 1993; Emperua *et al.*, 2017). There was no exact production data on flying fish caught in Philippine waters because the fishing method is not as developed as tuna, scads, or sardines (Simora *et al.*, 2016).

This wide variety of nutrition in the fish motivates many researchers to apply Postharvest, particularly in the low-value species of fish like Flying fish. The major components were water with 65-80%, fat (1-20%) and protein of 15-20% and it has minerals, vitamins and carbohydrates. Due to its excellent nutrition, this fish has a high potential as a raw material in post-harvest technology for the production of value-added products. In spite of this, it is crucial to conduct a baseline study on the handling practices of the fishermen to ensure food nutrition security (Molina, Daluddung and Amog, 2019).

The three trials of the drying process in three different settings are presented in Fig. 8. Along the blue line represents the fish product, it described the eight hours continuous drying processes in the drying chamber loaded with four kilos of flying fish (*C. oxycephalus*). Blue lined of the graph revealed the increase of temperature of 80 °F from the 8:30 to 9:30 in the morning, an increase of 20 °F from 9:30 to 10:30 in the morning, an increase of 20 °F from 10:30 to 12:30, in the afternoon from 1:30 to 4:30 the temperature range from 130 °F gradually decreasing to 110 °F it also revealed that the highest temperature rate during the test is 130 °F. It resulted in completing the drying process with the 4 kg. of raw flying fish that was loaded in the drying chamber of the prototype resulting in 2.2 kg. of dried fish, as shown in Picture 3 in the appendices. The prototype overrated the required temperature of the fisher folks and it also shortened the drying time of fish.

Fig. 4. Actual design of the fabricated dryer.

A related study was conducted by Hamdani and Muhammad (2018); the fish samples used were medium size queenfish.

The fish is cleaned from the scales and gutted, then split into two. After that, the fish was rinsed and weighed to know the overall weight of the whole fish. Fish weighing 26 kg, arranged in a drying rack for drying until the final moisture content is about 10-12%.

A red line in Figure 8 represents a 1.5 kg. of squid, which was also tested and evaluated in the same range of temperature 110 °F - 130 °F, but the drying process just lasted 3 hours. The 1.5 kg. raw material after the drying process resulted in 271 grams of dried product. It was found out that the squid dried faster within 3 hours compared to flying fish, drying with the same temperature reading scale. Squid is characterized by its high protein, low-fat content with a moisture content of about 80%. If not timely consumed and unless proper treatment is applied, squid may undergo rapid spoilage. Salting, smoking, and drying are the frequently used methods in the processing and preservation of squids. Sun-dried squid or "bulad (dried) posit (squid)" is commonly produced along coastal areas, whereas squids are caught almost all year-round. Typically, immediately caught squid must be cleaned before sun-drying, which lasts 2-3 days before packaging. In some operations, squid is sun-dried for at least one day, followed by two days of air drying.

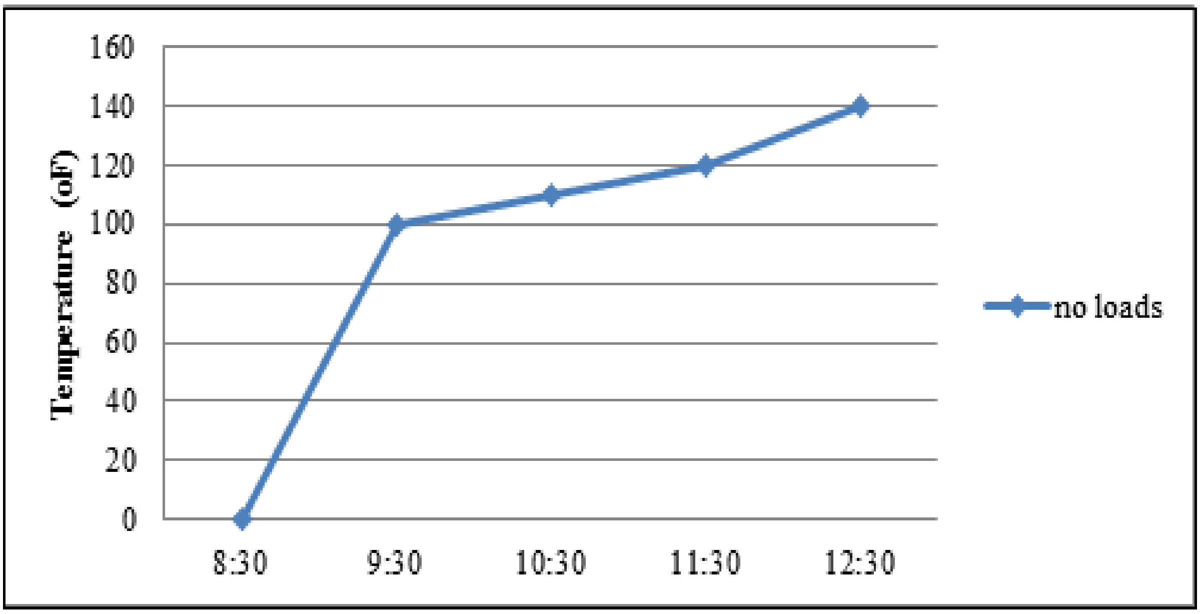

Fig. 5. The Time versus Temperature under no - load testing/trial.

It is believed that this protocol helps avoid molds and hence prolongs the product's shelf life (Gamal, 2016). The green line represents 3.0 kg. banana chips which were also tested and evaluated. This time it was found out that the food material dried within four hours which was also dried in lesser time compared to fish, drying with the same temperature reading scale. Fig. 7 indicates that the banana has lesser moisture content compared to fish resulting in a lesser drying time operated under the same temperature scale. Therefore, temperature ranges from 110 °F to 130 °F and time was 7-8 hours (fish), 3 hours (squid) and 4 hours (banana) respectively of the tree dried products.

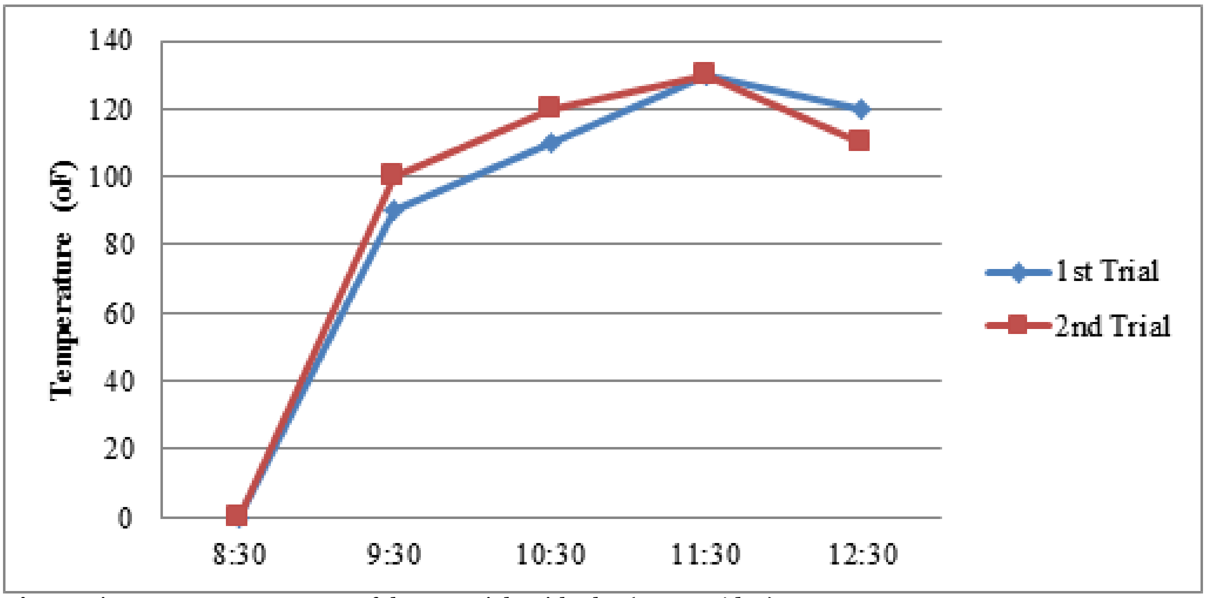

Fig. 6. Time versus temperature of the two trials with 2kg *(Oxocoetidae).*

Succeedingly, Table 2 below presents a summary of each product's initial and final weight, moisture, and solid content. The 2 kg. and 4 kg. of split flying fish (*C. oxycephalus*) was 1.2 kg. and 2.2 kg. after drying and takes 7-8 hours to dry with 40% and 45% moisture content and 60% and 55% solid content. While 1.5 kg. squids, after dried within 3 hours, were reported to have a final mass of .271 kg with 82% and

18% moisture and solid content, respectively and 3 kg. Banana resulted in 1.6 kg. Dried within 4 hours and has 47% moisture and 53% solid content.

According to Gamal (2016), squid is characterized by its high protein, low-fat content with a moisture content of about 80%. If not timely consumed and unless proper treatment is applied, squid may undergo rapid spoilage. Salting, smoking, and drying are the frequently used methods in the processing and preservation of squids. With this locally fabricated device, may help the local farmers and fisherfolks preserve their foods during wet season even more if there is bad weather disturbances for long in the region.

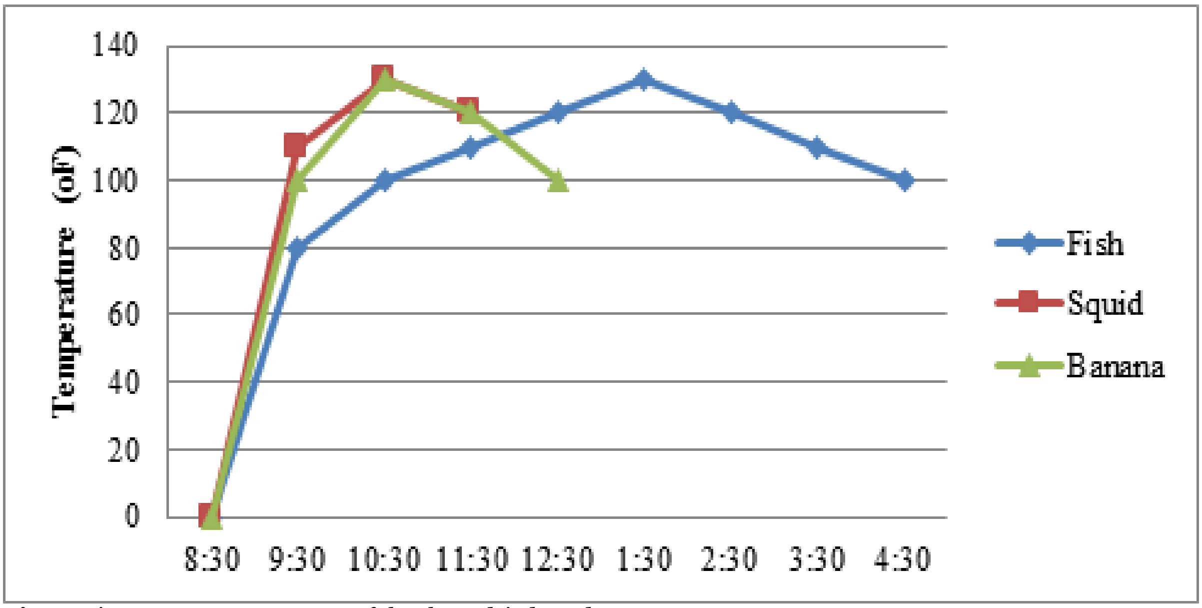

Fig. 7. Time versus temperature of the three dried products.

Conclusion

This concludes that the locally fabricated device was able to sustain and attain its temperature reading capacity and is capable of drying fish, squids, and bananas. It reveals that the fabricated device was tested only based on its generated temperature to a maximum range of 130 °F (54.44 °C) in the drying chamber that is suitable and can dry fish, fruits, and vegetables under certain normal conditions. Drying rate depends on the weather, temperature, speed of air movement and relative humidity of the air, kinds of foods to be dried, moisture and solid content of foods, fat content, size of fish or foods and whether sliced or not. The minimum and maximum drying temperature was 110 °F (43.33 °C) and 130 °F (54.440 °C), time taken for fish, squids, and banana were 7-8 hours, 3 hours, and 4 hours respectively and is suitable for drying. Further, the mass of wood as fuel should also be observed and recorded as a certain amount of energy burnt. Since the kind of fuel as a source of heat is vital in the study, it is therefore suggested to use biomass as a renewable energy source of heat energy for environmentally friendly energy production since coal emits toxic gasses after combustion. The different materials and resources used in the production of fabricated dryers should be economically utilized. The size of the furnace should also be considered since the generated hot air depends on the mass and kind of fuel used.

Conflict of Interest

There was no conflict of interest confirmed by the authors.

Acknowledgements

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was supervised by Prof. Rulyn R. Ladera in view to help the small scale farmers and fisherfolks in order to process their local foods during wet season.

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