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Effect of Drying Temperature on Final Moisture Content and Drying time of Dried Pawpaw (*Carica papaya*) Chips.

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ABSTRACT: *Pawpaw, loved by many for its health benefits, good taste and flavour is a nutritious fruit that is high in vitamins and carbohydrate. However, the fruit is seasonal and highly susceptible to deterioration after harvest. Therefore, there is a need to develop means of preserving the fruit for off season consumption. Hence, the aim of this research is to produce pawpaw chips and evaluate its drying kinetics at different samples thickness. Pawpaw fruits were procured from Nabest Food Farms, km 6 Ogbomoso-Ikoyi road, Nigeria. Healthy, good quality stocks were selected, manually peeled and sliced into four different thicknesses of 4, 6, 8, and 10 mm. Each sample was dried at 50, 60 and 70 °C temperatures with a locally fabricated cabinet dryer using standard methods. The final moisture content, drying time were determined at selected drying temperatures. There was a general decline in drying time as the drying temperature increased. The drying time for chips dried at 50, 60 and 70 °C for slice thicknesses 4, 6, 8, and 10 mm were 7.0, 11.5, 13.5 and 15 h; 6.5, 8.5, 9.5, and 11.0 h; and 5.5, 7.0, 9.0 and 10.0 h, respectively. When drying temperature was increased from 50 to 70 ºC, the final moisture content reduced from 16.57% to 13.09%.The results from this experiment would be useful in the designing of an automation machine for pawpaw chips production thereby helpingto attain SDG 2 (Zero hunger).*

Keywords:

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I. INTRODUCTION

Food insecurity is still a major global concern, Albert (2012) reported that one billion people are suffering starvation, under-, malnutrition. Also, FAO has concluded that there is still a long way to go in achieving Sustainable Development Goal (SDG) number 2, which is to have zero hunger by the year 2030 (Otekunrin, 2021). Food insecurity is not just about insufficient food production, availability and intake, it is also about the poor quality or value of food. Pawpaw is one of the cheapest and readily available sources of nutrients that can help achieve the MDG goal of eradicating malnutrition.

Pawpaw (Plate 1) is a fast-growing herbaceous, soft wooded perennial tree-like plant in the Caricaceae family that lives for about 5-10 years. It is a plant grown across all tropical countries such as Nigeria and many sub-tropical regions of the world, (Daagema *et al.*, 2020).

Plate 1: Pawpaw Tree
Source: Ojike *et al.* (2011)

The plant is believed to be native to the tropics of American and was first domestically cultivated in Mexico (Fuentes and Santamaría, 2014). In Nigeria pawpaw trees are grown throughout the year, its fresh and ripe fruits (Plate 2) are available towards the end of the year with its peak period between October and December. The fruits are one of the most nutritious and cheapest fruits found and consumed in Nigeria and its local names include Hausa-*Gwandargida*, Igbo- *Mgbimgbi*, Yoruba- *Ibepe*and Tiv-*Mbuawe(*Daagema *et al.*, 2020*).* Pawpaw fruits are ready for harvest about five to eight months after seed germination which is usually around five to six months after flowering. An average fruit ranges in size from about 7-30 cm long and vary in mass from about 250 to 3000g (Daagema *et al.*, 2020). Ripe papaya fruit have a smooth and thin yellow to orange skin; depending on the cultivar flesh, thickness also varies from 1.5 to 4 cm containing numerous grey-black spherical seeds which are usually about 5mm in diameter.

The tree has several uses which include: its ripe fruits eaten as food and also used in the production of smoothies and juices. The medicinal properties according to Pinnamaneni (2017) are found in the leaves and latex of the raw fruits which contains papain or papayotin majorly used in tenderizing meat and when fermented becomes an important product in the pharmaceutical industry. The latex is used in treating fever, stomach aches, beriberi and also as an anthelmintic (Alara *et al.*, 2020; Daagema *et al.*, 2020). According to Daagema *et al.* (2020) the Tiv tribe of Benue State from the Middle Belt region of Nigeria process the unripe fruits into chips or flakes and used for soup preparation while in Asian countries it is used for salad preparation (Pinnamaneni, 2017). Nutritionally pawpaw is higher in vitamin C, niacin, calcium and potassium than apples, oranges and bananas (Ojike *et al.*, 2011; Chukwuka *et al.*, 2013; Khatun *et al.*, 2016)

It is the only fruit with all essential amino acids and it is also loaded with antioxidants (Nam *et al.*, 2018; Daagema *et al.*, 2020). It contains carotenoids (β-carotene, cryptoxanthin), carbohydrates, sugars, vitamins A and C, dietary fiber, and minerals such as calcium, potassium and sodium. Daily consumption of fruits available in the tropics such as pawpaw, mangoes, oranges, pea etc. helps in the prevention against micronutrient deficiencies affecting the region especially in Sub-Saharan Africa (Santos *et al.*, 2014). Pawpaw trees are easy to cultivate and grows well in most parts of the country for its nutritional and medicinal potentials

Pawpaw is a seasonal nutritious fruit usually produced in abundance during its peak period of production between October and February but highly perishable which leads to quick deterioration. The postharvest losses of pawpaw due to inadequate availability of preservation or processing method in this part of the world has limited the availability of the fruits from plant round the year. Drying is a common and easily adoptable food processing and preservation method is therefore an option in converting the abundant fruits into shelf stable chips in order to minimize postharvest losses of the crop

Plate 2: Pawpaw fruit

Source: Ojike*et al* (2011)

II. MATERAILS AND METHODS

The pawpaw samples were procured from Nabest Food farms KM 6 Ogbomoso Ikoyi road, Ogbomoso, Oyo State, Nigeria(6.8111º N, 6.0187º E). Collection of the pawpaw samples from this source is preferred to buying from the market so as to ensure the homogeneity of the samples. Homogeneous varieties were selected according to maturity and colour.

2.1 DETERMINATION OF MOISTURE CONTENT

The Pawpaw was washed, peeled and the seeds was removed after which it was then cut into slabs of sizes 4, 6, 8 and 10mm thickness using a vernier caliper and stainless knife (Udomkun *et al.*, 2015). The initial moisture content was determined following the AOAC methodology using a drying oven (Gallenkamp, OVL Leicester, UK) and a weighing balance (Gallenkamp, Model MP10001) with an accuracy of ± 0.0001 was used to weigh the samples.

2.2 DETERMINATION OF FINAL MOISTURE CONTENT AND DRYING TIME

The initial weight of the slices was measured with an electronic weighing balance (Gallenkamp, Model MP10001). The drying experiment was carried out using a locally fabricated cabinet dryer available at the Crop Processing Laboratory in the Department of Agricultural Engineering LAUTECH, Ogbomoso. The temperature of the drying air in the drying chamber was controlled to suit the desired temperatures of 50, 60 and 70 ºC (Singh *et al.*, 2015). The dryer was allowed to run for 30 minutes before the commencement of the drying experiment in order to reach steady state. The drying process was continued till the samples attained a constant weight while weighing was carried out at intervals of 30 minutes using a Gallenkamp electronic balance (model MP 10001). At the conclusion of the drying process, the samples were cooled and were heat sealed in a low desity polyethylene bag for further analysis. However, the drying experiments was replicated three times, the averages of moisture content and drying time were recorded.

2.3 DETERMINATION OF DRYING RATE

The drying rate for pawpaw chips was calculated using Equation (1) (Da Silva *et al.*, 2014):

$$D_R = \frac{M_{t+dt} - M_t}{dt} \quad (1)$$

Where; M_{t+dt} = moisture content at t + d_t, kg water/kg dry matter and t = time, min.

III. RESULTS AND DISCUSSION

The results of the experiment on the effect of drying temperature and chips sizes on the drying time and final moisture content is as discussed below.The pawpaw chips were produced at three different drying temperatures of 50, 60, and 70 ^{o}C with four different sizes of thickness (4, 6, 8 and 10 mm) and are as shown in Plate 1 (a) and (b). The results of the experiments was used in drawing drying curves (Figures 1,2 and 3). Thedrying curves are very useful in understanding the kinetics of how a product dries under aspecific set of drying temperature. The study of the drying curveof pawpaw chips shows three stages of drying. The first stage represents settling down stage which can be negligible, the second stage represents the falling rate curve while the last stage reprensent the equillibrum drying period. Figure 4-6 shows the result of the relationship between the moisture content and chips size on drying rate. The result is in agreement with Phong *et al.* (2023) and Korese and Achaglinkame (2024).

3.1 Effect of drying temperature on the drying time

The effect of drying temperature on the drying time of the pawpaw chips is as presented in Figure 7. There is a general decline in drying time as the drying temperature increased due to increase in heat supplied to the samples. When chips are dried at 50 ºC, and slice thickness of 4, 6, 8, and 10 mm the drying time is 7, 11.5, 13.5 and 15 hours respectively while when chips dried at 60 ºC and slice thickness of 4, 6, 8 and 10 mm the drying time is 6.5, 8.5, 9.5, and 11 hours. While for chips dried at 70 ºC and slice thickness of 4, 6, 8, and 10 mm the drying time is 5.5, 7, 9 and 10 hours respectively. With increase in slice thickness there is a corresponding increase in drying time, drying conducted 50 ºC and 10 mm slice thickness had the longest drying time of 15 hours while 70 ºC temperature and 5 mm slice thickness gave the shortest drying time of 5.5 hours, this could be attributed to ease of heat penetration in the sample to cause moisture removal, this is similar to the trend reported by Chin et al. (2015) when different slices of Kiwi fruits were dried.

3.2 Effect of drying temperature on final moisture content

The effect of drying temperature on the final moisture content of the pawpaw chips is as presented in Figure 8. It was observed that as the drying temperature increases, the final moisture content decreases. The result shows that when the drying temperature increased from 50 to 70 ºC, the final moisture content decreased from 16.57% to 13.09%. In conventional mechanical drying, setting heat and mass transfer always results in the removal of moisture by thermal flow with the help of heated air. As the temperature of the air that flows across the surface of the pawpaw slice increased, the final moisture content decreased. This report of decreased moisture content with an increase in drying temperature was in agreement with the findings of Idah *et al.* (2010) on dried tomatoes, and Idowu and Adewumi (2021) on fermented cassava flour

Plate 1: (a)The dried Pawpaw Chips, (b) Produced Pawpaw Chips

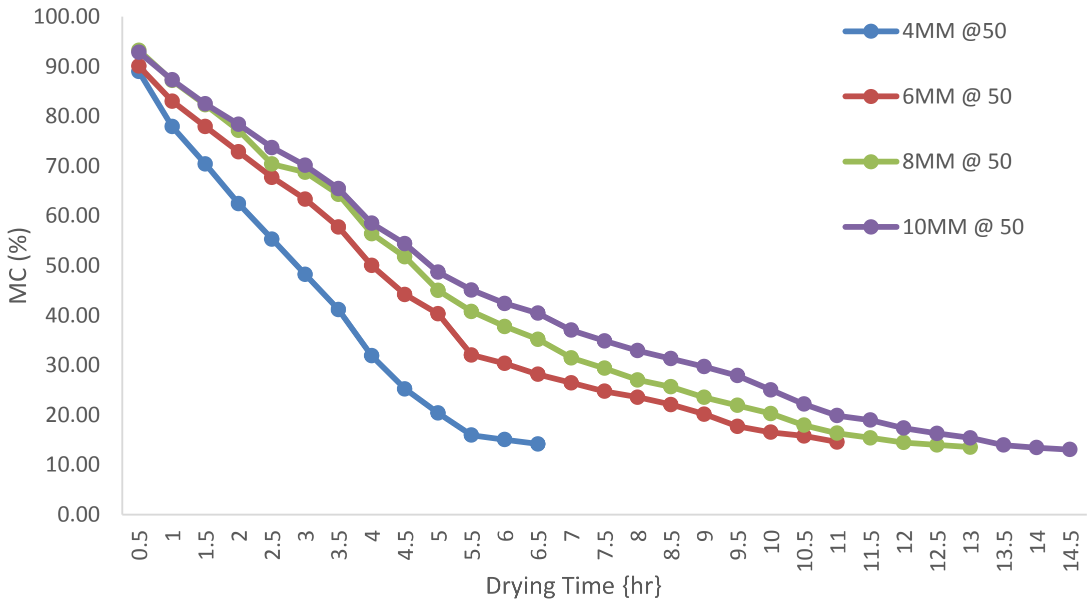

Figure 1: Drying curve of chips dried at 50 ^oC

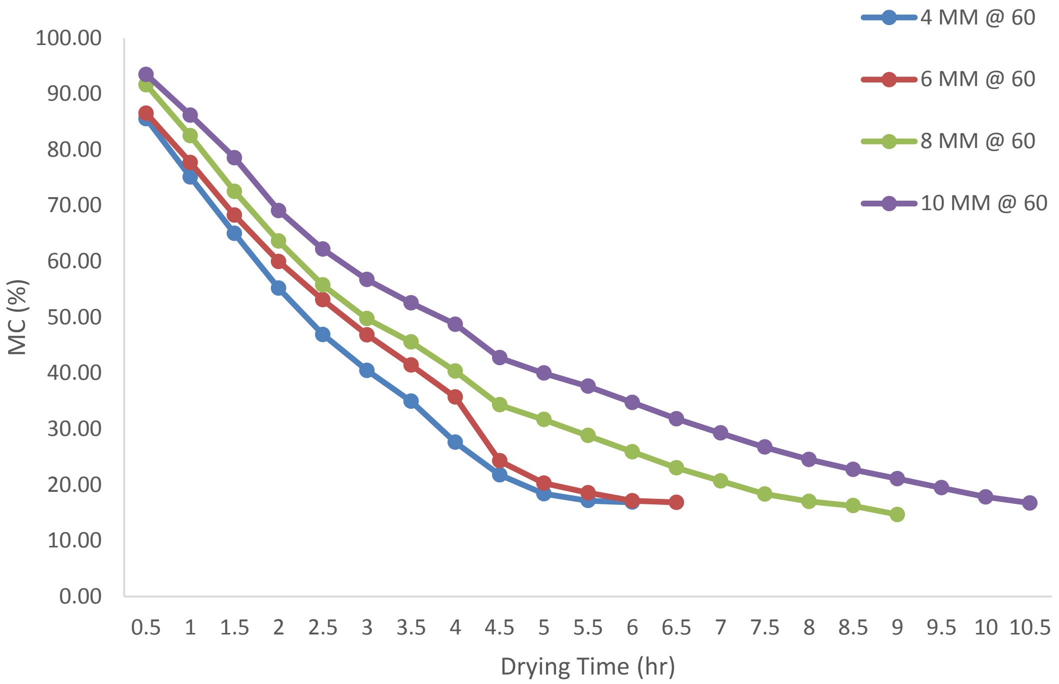

Figure 2: Drying curve of chips dried at 60 °C

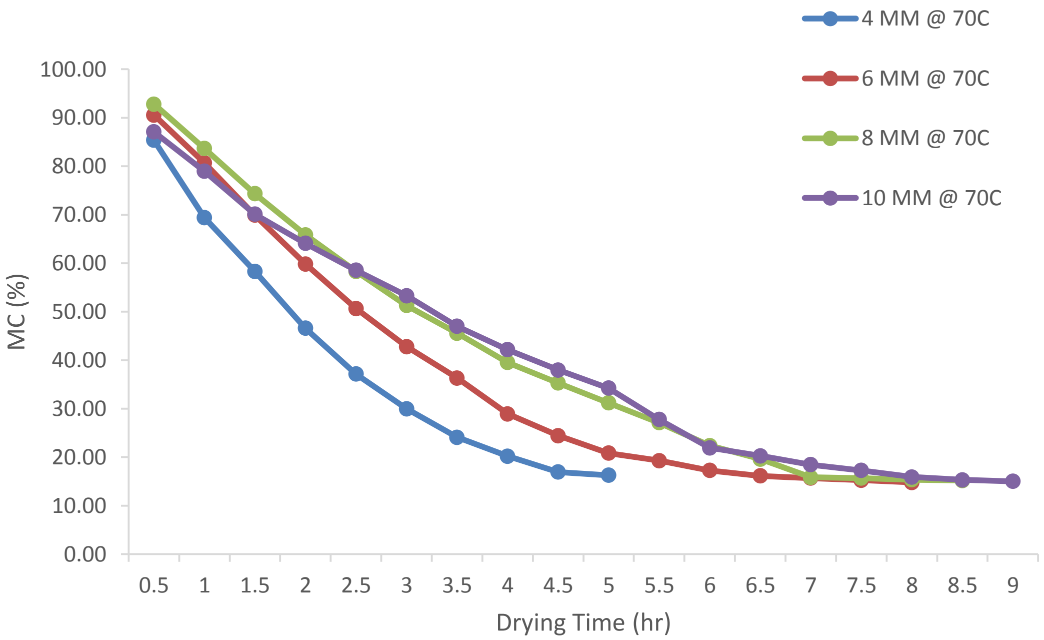

Figure 3: Drying curve of chips dried at 70 °C

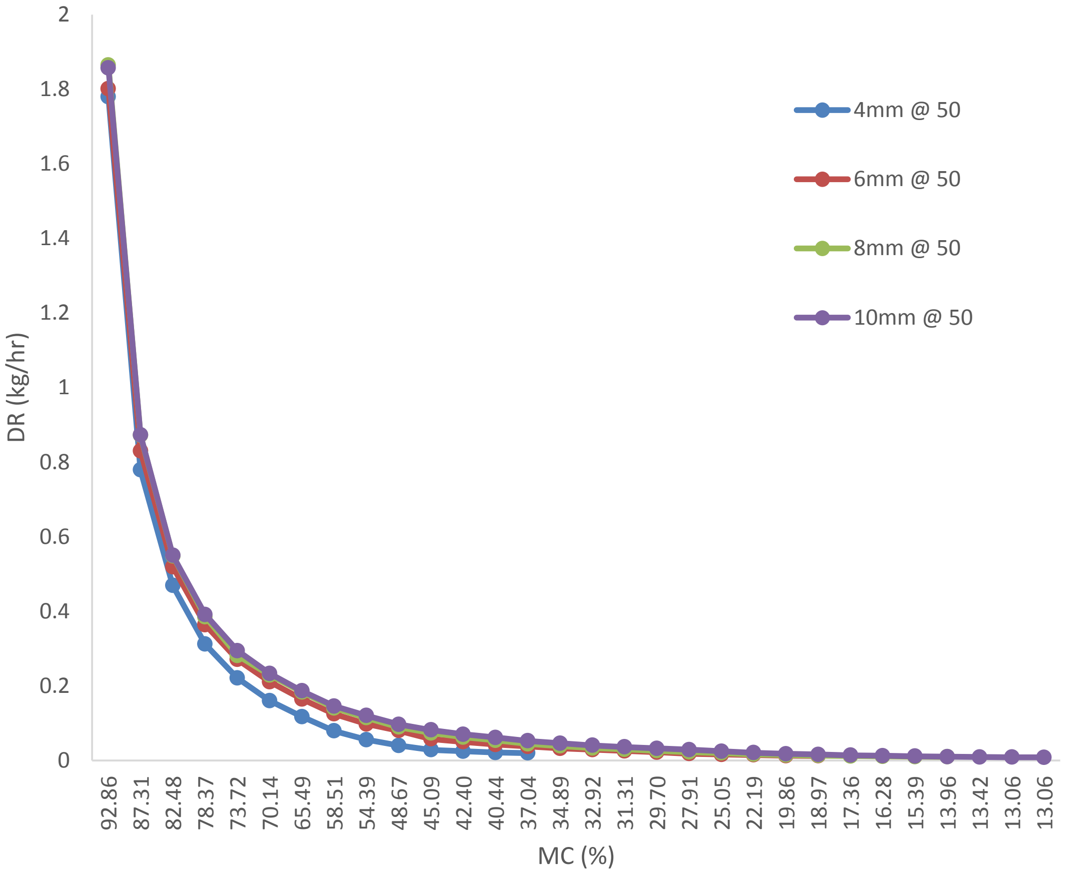

Figure 4 : Effect of moisture content and chips size on drying rate of chips dried at 50 °C

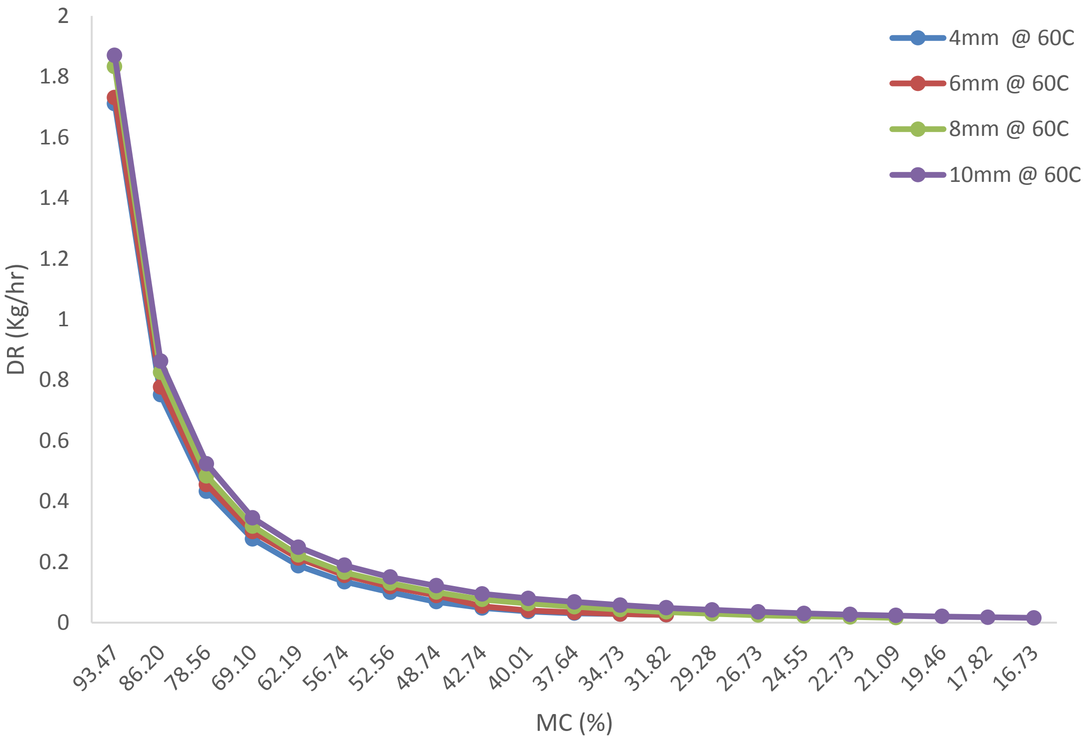

Figure 5 : Effect of moisture content and chips size on drying rate of chips dried at 60 °C

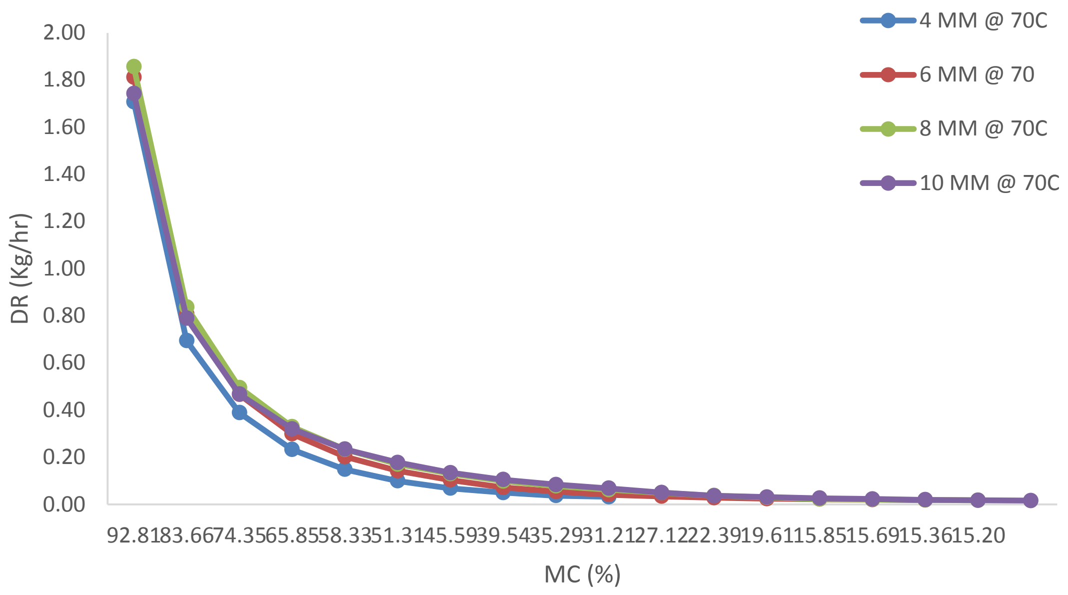

Figure 6 : Effect of moisture content and chips size on drying rate of chips dried at 70^{o}C

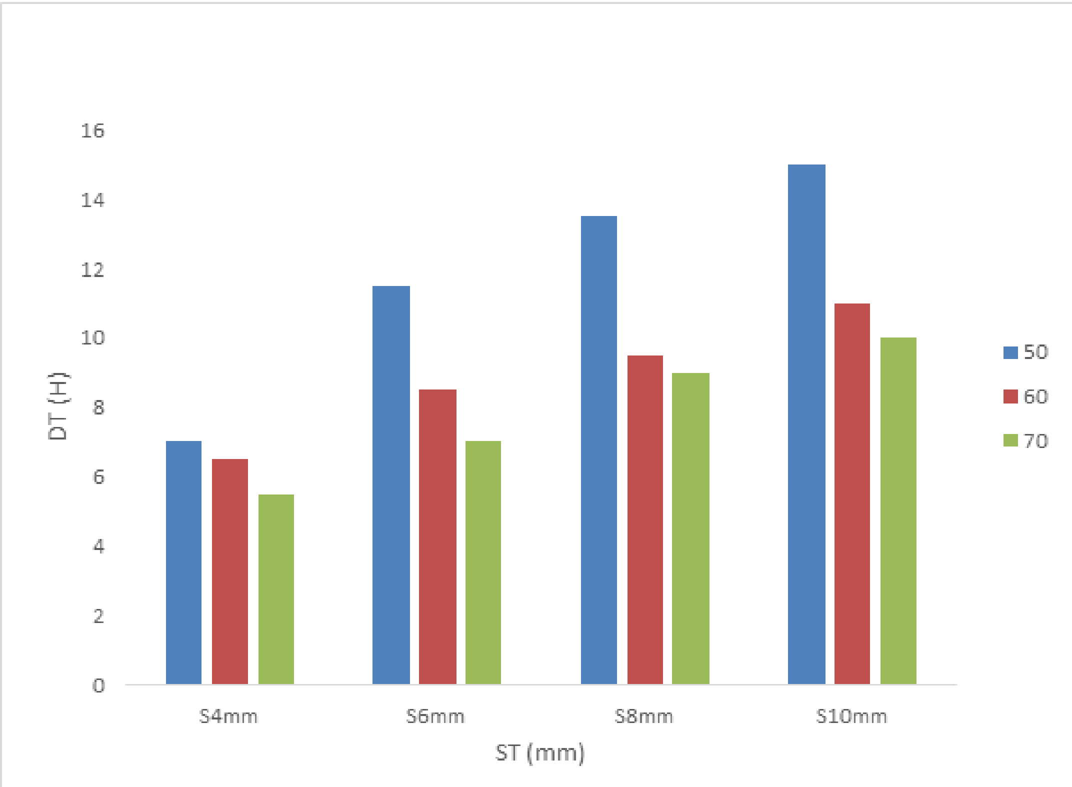

Figure7: Effect of temperature on drying time

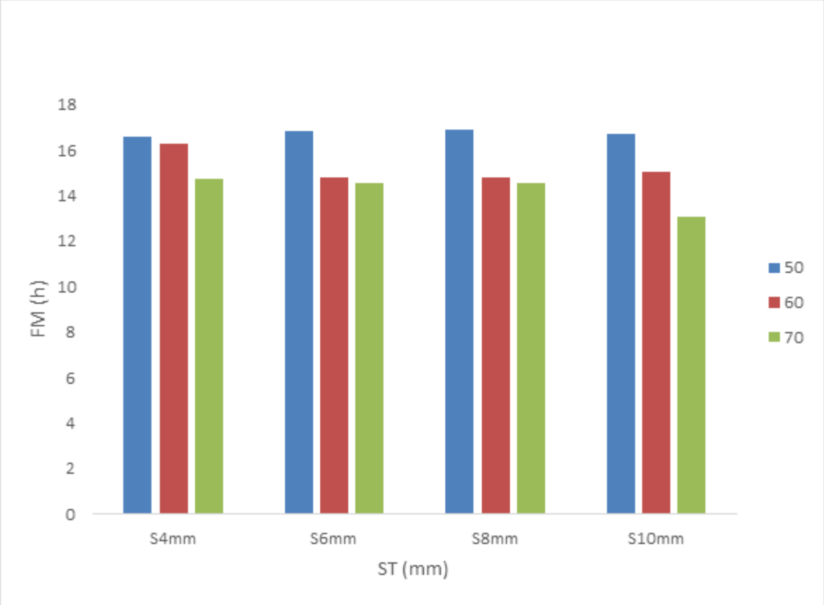

Figure 8: Effect of temperature on Final Moisture content

IV. CONCLUSION

From the study carried out, it was concluded thatdrying temperature is a major factor in the drying of pawpaw chips. The final moisture content is afunction of drying temperature. With increase in drying temperature, there is a corresponding reduction in final moisture content. Also, the result establishes that increasing the drying temperature reduces the drying time.

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