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STUDY ON DRYING OF FERMENTATED COCOA BEANS (Theobroma cacao)

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ABSTRACT: In this study, cocoa beans were subjected to hot air drying in a tunnel dryer at 50, 55, 60, 65, 70, 75, 80 and 85^{o}C. The proximate, chemical and physical attributes of the samples were investigated. The results show that higher temperature of drying conferred higher drying rate on the samples; proximate, chemical and physical analyses were inversely related in most cases. The drying process employed would help in the preservation of the nutrients of the cocoa products.

KEYWORDS: cocoa beans, temperature, fermentation, quality and health benefits.

1 INTRODUCTION

Cocoa (*Theobroma cacao*) originated from Amazonian region of Brazil and is grown in tropical countries like Nigeria, Ghana, Ivory Coast, Brazil, Malaysia, Venezuela and Indonesia (Beckett, 1994). World production cocoa beans were about 3, 888, 000 tonnes in 2006/2007 crop year and nearly 40% of this quantity was produced in Cote d'ivoire (World Cocoa Foundation, 2008). Cocoa is one of the major cash crops through which agriculture contribution to Nigeria economy, the contributions of cocoa to the nation's economic development are vast (Folayan et al., 2006). Cocoa trees grow in a limited geographical zone, of approximately 20 degrees to the north and south of equator (Buijsse et al., 2006). It was introduced into Nigeria in 1874 through Equatorial Guinea by the Portuguese traders and has been grown extensively in the South-Western part of the country (Opeke, 1987). Cocoa beans is mainly consumed as chocolates and widely used in beverages, cosmetics, pharmaceuticals and toiletry products (Porter, 2006, Taubert *et al*., 2007).

The processing of cocoa beans consist of two major steps namely fermentation and drying (Hill et al, 2009). Different methods of fermentation and drying are followed in the cocoa growing countries (Wood and Lass, 1985). The beans and associated pulp are removed from the pod and subjected to microbial fermentation which is generally conducted as traditional, indigenous processes and constitute the first stage in preparation for chocolates production (Ardhana and Fleet, 2003). Fermented cocoa beans present generally moisture content between 55% and 60%. After fermentation, the beans are dried immediately to avoid over fermentation, which could lead to product deterioration.

In Nigeria, methods of drying the beans are usually by sun drying which is simple and cheap: not requiring the expensive mechanical devices used in the artificial dryers but it is also labour-intensive and there is much concern for hygienic condition of the product. Artificial, hot air drying of fermented cocoa beans has been reported in literatures, and mostly concentrated on the removal of moisture from the beans at the shortest possible time (Nganhau et al., 2003) but the effect of drying temperature on the overall nutritional contents has been given the little attention as far as literature is concerned. Therefore, the objective of this study is to investigate the effect of drying temperatures on the quality attributes of coco beans.

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2 MATERIALS AND METHOD

2.1 MATERIALS

The material used was cocoa beans, basket, wooden mallet, banana leaves and tray. These materials were obtained from a local market in Ifetedo, Osun state.

2.2 DRYING OF COCOA BEANS IN A TUNNEL DRYER AT DIFFERENT TEMPERATURES

Fresh cocoa beans pods were bought from cocoa farmers on the farm in Ifetedo, Osun State, Nigeria. These pods were opened with a stainless knife and the wet beans were removed from the pods. Basket method fermentation was used, the insides of the basket were covered with banana leaves but the bottom was remained uncovered to let the sweating drain away. The beans were turned on each day for four days to allow proper fermentation of the beans. The fermented beans were spread on a tray and dried inside the tunnel dryer at 50, 55, 60, 65, 70, 75, 80 and 85ºC.

2.3 STATISTICAL ANALYSIS

The (2009) SPSS 15.0 version, a software package was used for statistical analysis. Analysis of variance (ANOVA) was carried out on the data obtained from the physical and chemical analysis of the samples. Duncan test was used to separate the means.

2.4 ANALYSES DETERMINATION

2.4.1 PROXIMATE ANALYSIS DETERMINATION

Fibre, carbohydrate, fat, protein, ash and moisture content were determined using AOAC (2000) method.

2.4.2 CHEMICAL AND PHYSICAL DETERMINATION

Bulk density and pH were determined using AOAC (2000) method.

3 RESULTS AND DISCUSSION

3.1 DRYING RATE PATTERN OF THE COCOA BEANS

The drying rate of the samples is as shown in Figure 1. It is observed from the figure that the drying rate form a falling rate pattern in which the slope of each of the curves descended and flatten off at the end using different times. As reported by Ajala *et al.* (2013), that one of the key factors that affects the rate of drying rate is drying temperature. The greater the temperature difference between the drying air and the food, the greater the heat transfer to the food. It is observed that drying rate pattern takes shorter time at 85^{o}C than other temperatures because drying kinetics depends largely on temperature in food materials as reported by Ajala et al., (2012) and Hii *et al.,* (2009). Higher temperature of drying resulted in a higher driving force for moisture removal which shortened the overall drying time. According to Hii *et al.,* (2009), too high drying rate was not recommended for cocoa drying as this will retain most of the acids inside the beans and caused excessive acidity in the finished powder. Excessive acidity will cause improper flavour developments and the sour note cannot be removed especially when the samples are used for chocolate process. (McDonald etal., 1981; Jinap *et al*., 1994)

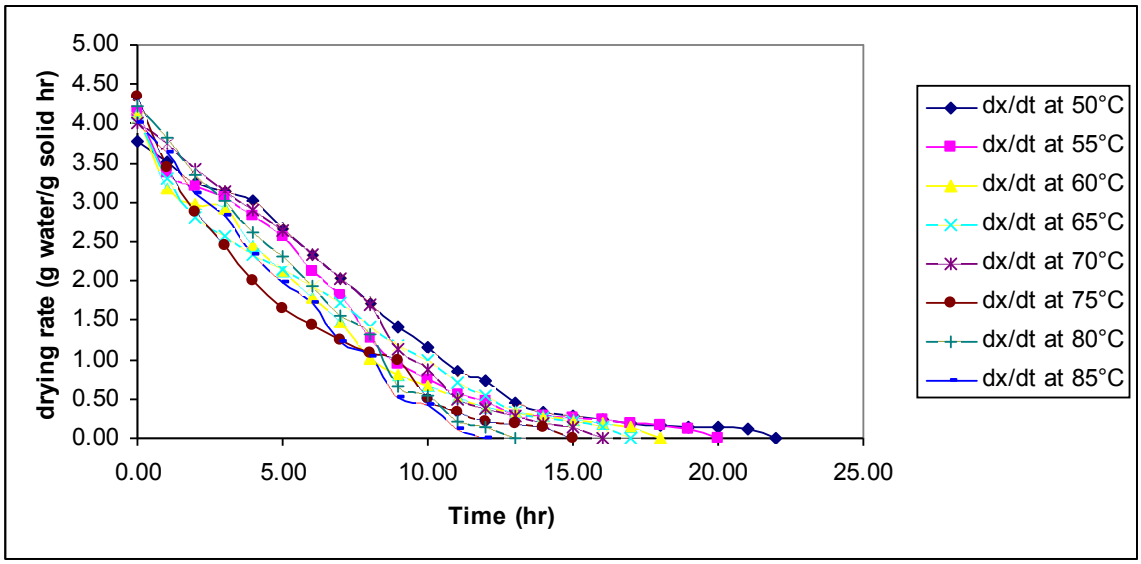

Figure 1 showing drying rate against time during the drying operation of cocoa beans

3.2 RESULTS OF THE PROXIMATE ANALYSES OF THE COCOA SAMPLES

Table 1 shows the values of protein content of the cocoa beans, the values range from 6.11 to 9.25 %. The values show a level of significant difference among the samples (p<0. 05). The protein values in this work are comparable with the values reported by Ndife *et al.* (2013). The protein content decreased as the drying temperature increased. This is similar to the observation of other researchers such as by Sefa – Dedeh and Kofi-Agyir, (2002). The protein content of cocoa is health improving as it helps in the functioning of liver and kidney, alanine aminotransferase, aspartate aminotransferase of cocoa helps to detect and monitor cardiac disease (Abrokwah *et al.,* 2009).

Fibre content results show that the values range from 1.075 to 2.19 % and the values are significantly different from one another. These values are close agreement with the value of 1. 80% reported by Ndife *et al.,* (2013). Furthermore, Ndife *et al.,* (2013) had earlier reported that fibre content decreased with increase in fermentation time, the values reported in this study has shown that as drying temperature increased, the values fibre content increased. Physicians and scholars alike have touted the health benefits of fiber, including a lowered risk of diabetes and heart disease. Example of one of such scholars is Finley (2014) who also noted that combining the fiber in cocoa with prebiotics is likely to improve a person's overall health and help convert polyphenolics in the stomach into anti-inflammatory compounds that are good for the heart.

Table 1: Proximate composition of cocoa beans

Sample	Protein (%)	Fibre(%)	Ash(%)	Moisture(%)	Fat(%)	CHO(%)
A	9.250±0.014h	1.075±0.007a	6.305±0.02h	7.005±0.007h	12.015±0.021h	67.24±0.000a
B	8.905±0.007g	1.265±0.007b	6.125±0.007g	6.685±0.007g	11.935±0.007g	67.330±0.014a
C	8.345±0.007f	1.325±0.007c	6.005±0.007f	6.275±0.007f	11.605±0.007f	67.58±0.007a
D	8.205±0.007e	1.395±0.007d	5.785±0.007e	5.925±0.007e	11.345±0.007e	67.84±0.04a
E	7.855±0.007d	1.755±0.007e	5.675±0.021d	5.685±0.007d	10.965±0.06d	67.98±0.02a
F	7.00±0.007c	2.032±0.007f	5.565±0.021c	5.350±0.014c	10.560±0.000c	67.98±0.02a
G	6.695±0.007b	2.105±0.007g	5.470±0.014b	5.165±0.021b	10.345±0.007b	67.92±0.042a
H	6.110±0.014a	2.190±0.024h	5.315±0.007a	4.965±0.066a	10.115±0.007a	73.00±7.07a

**values with the same subscript are not significantly different but values with different subscript are significantly different.*
**sample code: A=5OºC, B=55ºC, C=60ºC, D=65ºC, E=70ºC, F=75ºC, G=80ºC, H=85ºC*

The ash contents vary from 5.315 to 6. 305% and the samples are significantly from one another. The values reported in this work are greater than those reported by Ndifel *et al*. (2013) but closer with the values reported by Fanny *et al.,* (2000). The values show an inverse relationship with the drying temperatures because as the drying temperature increased, the ash content decrease. This observation was earlier reported by Blanco et al. (2004) on roots and tubers(cocoyam). Ash is an

indication of mineral contents of foods and has been shown by Leggli *et al*. (2011) to be high in cocoa products Cocoa contains iron for red blood cells, however, it boost the white blood cells which are responsible for the protection against infection (Abrokwah *et al.,* 2009). Adai (2009) has earlier reported that cocoa can strengthened the body immune system and prevents many viral diseases.

The moisture values of the cocoa powder are as presented in Table 1. The values ranged from 4.965 to 7.005% and are greater than the values reported by John *et al.* (2012) but are closer to those values reported by Ndife *et al.* (2013). The samples are significantly different from one another and the results show that higher temperature decreased the moisture content level of the samples. Temperature contribute to the loss of moisture content in the beans to a minimum value and the assurance of its microbiological purity (Redgwell et al., 2003). Abiola and Tewe (1991) reported that key factors for long shelf-life in cocoa powder are the control of the moisture content. Low moisture content confers higher shelf-life to the cocoa powder as microbial attack is minimal thereby keeping the nutritional ingenuity contact. Furthermore, effective control of moisture content of the powder reduces the water activity, oxidation and rancidity which inhibit good quality in cocoa beans.

The fat contents vary from 10.115 to 12.015 % and the values exhibited a level of significant difference among each other. These values are greater than the values reported by John *et al.* (2012) but are in close range with the values reported by Ndife *et al.* (2013) which are 10.05-12.65%. The fat profile helps to reduce the risk of coronary heart disease because the flavonoids in cocoa are capable to cause the modulation and prevent the oxidation and increase in cholesterol which could cause higher risk of heart disease as reported by Osakebe, *et al.,* (2000)

The carbohydrate values range from 67.24 to 73.00 % and are not significantly different from one another. The values of carbohydrate in this work are comparable with the values (61.0 - 62.48 %) reported by Ndife et al. (2013). The high percentage of carbohydrate in cocoa powder is health advantage especially for growing kids who need high calorie food to meet energy daily requirement and because low-energy foods tend to limit the optimal utilization of other nutrients through the protective effect of carbohydrate on protein and polyphenols (Belscak et al., 2009; Lettieri-Barbato et al, 2012).

3.3 RESULTS OF CHEMICAL AND PHYSICAL ANALYSES OF THE SAMPLES

Table 2 shows the pH of the cocoa powder, the pH contents show that all the samples are slightly acidic. The values range from 5.715 to 6.085 and sample H is significantly different from others. Sample A also is significantly different from others but samples B, C, D, E, F and G are not significantly different from one another. The values of pH in this work shows that it is less acidic and is in close range with the values reported Tagro *et al*. (2010) which range from 4.5 to 5.5. The pH of the sample decreased as the drying temperature increased. This is because at higher temperature, evaporation of moisture occurs rapidly as reported by Franke *et al*. (2008), this resulted in less evaporation of acetic acids in cocoa samples as reported Tagro *et al* (2010). The pH level of cocoa sample shows it is acidic which makes it possible to be preserved for appreciable amount of time before oxidation can set in.

The bulk densities of the samples vary from 4.277 to 5.481 g/cm^3 and are significantly different from each other. These values are less than the values (10.76) reported by Ndife *et al.,* (2013). The bulk density is an important consideration in transporting, storing and packaging particulate materials (Onwuka, 2006). The bulk density of cocoa powders is affected by their moisture contents (Ajala *et al.,* 2014). The bulk densities seem to increase as the percentage moisture loss in most of the cocoa powder samples decrease due to the increase in temperature.

Table 2: chemical and physical properties of cocoa beans

Samples	pH	bulk density (g/cm^3)
A	6.085±0.02e	5.481±0.03e
B	5.995±0.007d	5.431±0.03d
C	5.930±0.02c	5.404±0.02d
D	5.775±0.007b	4.456±0.006c
E	5.770±0.01b	4.420±0.03b
F	5.765±0.007b	4.393±0.002b
G	5.760±0.01b	4.289±0.002a
H	5.715±0.007a	4.277±0.05a

**values with the same subscript are not significantly different but values with different subscript are significantly different.*
**sample code: A=50ºC, B=55ºC, C=60ºC, D=65ºC, E=70ºC, F=75ºC, G=80ºC and H= 85ºC*

4 CONCLUSION

From the results obtained on the analysis, it can be concluded that the effective drying process affects the quality properties of cocoa as protein values was higher at lower temperatures while others increased with increase in temperatures. Value of pH was less acidic at lower temperature of drying which is a better quality in cocoa powder.

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