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Effects of oven and sun drying processing techniques on organoleptic characteristics of cassava (*Manihot esculenta*) flour and fufu

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Abstract

A research study was conducted at the Laboratory of Agricultural Education Department of the Federal College of Education (Technical) Omoku to ascertain effects of sun and oven drying processing technics on the organoleptic characteristics of flour and fufu obtained from three cassava varieties. The cassava varieties (TMS 419, bitter carotene and TMS 30555) were obtained from the teaching and research farm of the college and used for the study. Blanched, Retted and Directly processed cassava tubers, were subjected to two drying methods (oven and sun drying). It was a 32-factor factorial experiment fitted into Completely Randomized Design (CRD). Flour obtained from the different processing techniques was made into fufu. Flour and Fufu obtained were served to 20 panelists whose responses were obtained and analyzed. Results obtained indicates that in TMS 419, sun drying processing techniques recorded an acceptable flour texture with the blanching. Again, better and acceptable flour texture was obtained with sun drying method, in both Bitter carotene and TMS30555 cassava varieties and across blanching, retting and use of direct methods of processing. Acceptable and better flour colour were obtained with the use of sun drying to process each of the cassava varieties. Sun drying also recorded higher fufu acceptability. Similarly sundried TMS 30555 and bitter carotene cassava varieties recorded an acceptable fufu aroma and better fufu draw-ability index suggesting that sun drying is better than oven drying method of cassava processing for preparation of acceptable fufu.

Keywords: Processing; Techniques; Organoleptic; Cassava; *Manihot esculenta*; Flour; Fufu; Oven

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1. Introduction

Cassava (Manihot spp.) is a dicotyledonous crop and a member of the family Euphorbiaceae and the genus Manihot. It is an important root crop and is an essential food source in Nigeria and across Sub-Sahara Africa. It is known to provide over 50% of the energy for an estimated 500million people in Africa (IITA, 1992), Currently, Nigeria is the largest producer of cassava with an annual production of 31.2 million tons (FMARD 2002). Increased production of associated products can be linked with the continuous development of technology at the National Root Crop Research (NRCRI) Institute and International Institute of Tropical Agriculture (IITA) located at Umudike and Ibadan respectively.

The production and utilization of cassava must be given attention in Nigerian food policy since it is not only a chief source of dietary food energy but also a veritable source of carbohydrate for most people. Cassava leaf is consumed as vegetable by humans, and it is a delicacy that is relished by sheep and goats. Tubers could be processed into starch, chips, ethanol, glucose, as well as into flour and paste that are frequently used for the preparation of fufu. Methods employed in the processing of cassava into various products differ in accordance with consumer preference and prevailing customs, both in Africa and across the world.

Freshly harvested cassava tubers do not store for a long period of time, as it contains about 70% moisture, causing its tubers to deteriorate very easily. Processing harvested tubers into various products is a sure way of prolonging shelf life, enhance products transportation, marketing and reduce cyanide content. In addition to improving palatability. Processing is also used to secure improved nutritional value through increased food composites and fortification, thus increasing protein value and secure nutrient rich food products. Nutritionally, cassava contains potassium, iron, vitamin A, folic acid, Sodium, Vitamin C, Vitamin B6 and protein. The protein content increases three to eight times when fermented (Nwachukwu and Edwards, 1987).

The sensory evaluation strategy is a standard used to assist consumers, goods manufacturers, and developers in the evaluation of their goods to ensure product quality, consumer satisfaction, general acceptability and marketing success (Cock, 1985). Cassava tubers when processed into high quality cassava flour can be used to make bread, cakes, doughnut, chin-chin, biscuits and starch (Nwakor et. al, 2008). Processing of cassava into flour is simply the conversion of the tubers into powder that is convenient to handle, store and/or use. However, producing cassava flour for fufu preparation require a process slightly different from the process employed in the production of flour for bread, and starch.

The direct processing method is employed for production of high-quality unfermented cassava flour for the preparation of bread and starch (IITA, 1990). This involves, sorting, peeling, washing, grating, dewatering, pulverization, drying, and milling harvested tubers into fine flour and packaging it for use. Flour obtained through this method, cannot be used effectively for preparation of good quality fufu.

Food product fermentation is a common household technology, which is known to improve nutritive value of root and tuber crops (Obizoba, 1990; Nnam, 2000; Obadina, 2006). Advantages of locally fermented food include enhanced organoleptic characteristics and preservation of properties/ improvement in nutrition quality, detoxification, and production of antibiotics (Oyewole and Isah, 2012).

Hitherto, preparation of cassava tuber for fufu is achieved through tuber fermentation process that involves retting of peeled or unpeeled cassava tuber, which is subsequently, sieved and dewatered to obtain a paste (Oyewole and Philip, 2001) that is then parboiled, boiled, and pounded with mortar and pestle to obtain a sticky dough called fufu (Isirima et al., 2018). This sticky dough is moulded into a small boll that is steep into a well-prepared soup and swallowed as food. Some consumers resent fufu prepared with this fermentation process, because of the characteristic's odour associated with it. Besides, this local process of preparing fufu through cassava tuber fermentation is rigorous and time consuming. This calls for the development a fufu preparation strategy that is easy, less rigorous and that produce fufu that is generally acceptable to the consumers. The cassava tuber to flour production process becomes the next best alternative. The aim of this study therefore is to develop a fufu preparation strategy or process that is less cumbersome and whose end product will be relished and cherish by the fufu consuming populace. Flour is far easier to handle, transport and preparation of flour into fufu is far easier than transforming locally prepared cassava paste into fufu.

1.1. Objective of the study

The specific objective of this study is to determine:

1) effect of sun and oven drying on acceptance of flour obtained from different cassava varieties.
2) effect of the drying methods on sensory or organoleptic characteristics of fufu gotten from cassava varieties subjected to sun and oven drying treatments.

2. Methodology

2.1. Study location

The study was located at the Agricultural Education laboratory, Federal College of Education Technical, F C E (T) Omoku in Ogba, Egbema Local Government Area of the Rives state in the Niger Delta Region of Nigeria.

2.2. Experiment design

It was a quasi-experiment that consists of both laboratory and a survey study. It was a 2´3 split plot factorial experiment with 2 treatments at 3 distinct levels. The treatments were three (3) cassava varieties (TMS 419, TMS 30555 and Bitter carotene), Three processing methods: direct, retting and blanching and two (2) drying methods: - Sun drying and oven drying methods. TMS 30555 is chosen as the control study because it is the longest-existing variety in the study area and is commonly used in the production of paste for making fufu.

2.3. Study sample

The survey aspect of the study targeted all fufu -Consuming individuals in the Study Area. From this group a sample of twenty (20) respondents were randomly selected and their opinion gathered using a well formulated questionaire designed in a 7-point hedonic rating scale format.

2.4. Study material

Cassava tuber varieties used for the study were harvested fresh from the teaching and research farm of the Agricultural Education Department of Federal College of Education (FCE) Technical Omoku. The tubers were carefully sorted, peeled, washed, sliced, and weighed with the aid of a sensitive weighing balance. Slices of each cassava variety were separately weighed and subjected to direct, blanching and retting (fermentation) methods of processing. The cassava chips were later subjected to oven and sun drying methods and subsequently ground into flour which were eventually prepared into fufu by stirring the flour in a pot of boiling water to obtain a sticky dough consumed as fufu. Both flour and fufu obtained were served to 20 panel members known to relish cassava fufu. The responses of the panelist were obtained with the aid of the questionnaire instrument, which was administered and collected almost immediately.

2.5. Questionnaire instrument

The questionnaire items structure in 7-piont hedonic rating scale (dislike extremely, dislike moderately, dislike slight, like, likely slight, like moderately, likely extremely) was administered to illicit response from respondents and collected almost immediately. Data collected were subjected to statistical analysis using GenStat analytical tool and response graphically displayed.

3. Results

3.1. Flour texture

Results obtained on the effects of oven and sun drying processing methods on cassava flour texture and colour are presented as shown in the Figures 1a, 1b, and 1c.

TMS 419 Cassava variety: In TMS 419, flour textures of the sun-dried cassava chips were more acceptable with the use of direct processing method of flour production. The flour texture in the blanching method of processing did not show any significant difference ($p \geq 0.05$) across oven and sun drying processing methods, however in the retted method of processing, flour texture of the oven dried method was more acceptable than flour obtained from the sun drying (Figure 1a).

Bitter carotene: Sun drying techniques recorded higher and better flour texture rating across direct, blanching, and retting methods of cassava flour processing in bitter carotene variety.

TMS 30555 (Figure 1c): Moreso, sun drying methods of flour processing recorded higher and acceptable flour texture across the direct, blanching, and retting methods of flour processing in TMS 30555 (Figure 1c). Analysis of variance shows that the observed variability in drying methods, differed significantly($p \leq 0.05$) across the various processing methods both bitter carotene and TMS 30555, but texture rate did not differ significantly in TMS 419 across the processing and drying methods.

3.2. Flour colour

The colour of the sun-dried flour (TMS 419) was more acceptable to the assessors than oven dried flour, across all processing methods (direct blanching and retting) methods of processing employed (Figure 2a). Similar observations were recorded for bitter carotene and TMS 30555 across the various processing methods (Figure 2b and 2c). Though, ANOVA result did not detect any significant difference ($p \geq 0.05$) in the observed variability across direct, blanch and retting processing methods employed, degree of likeness of flour colour obtained in

TMS 419 cassava varieties with the use of sun drying method differed significantly (p ≤0.05) from flour colour obtained with oven dried cassava flour.

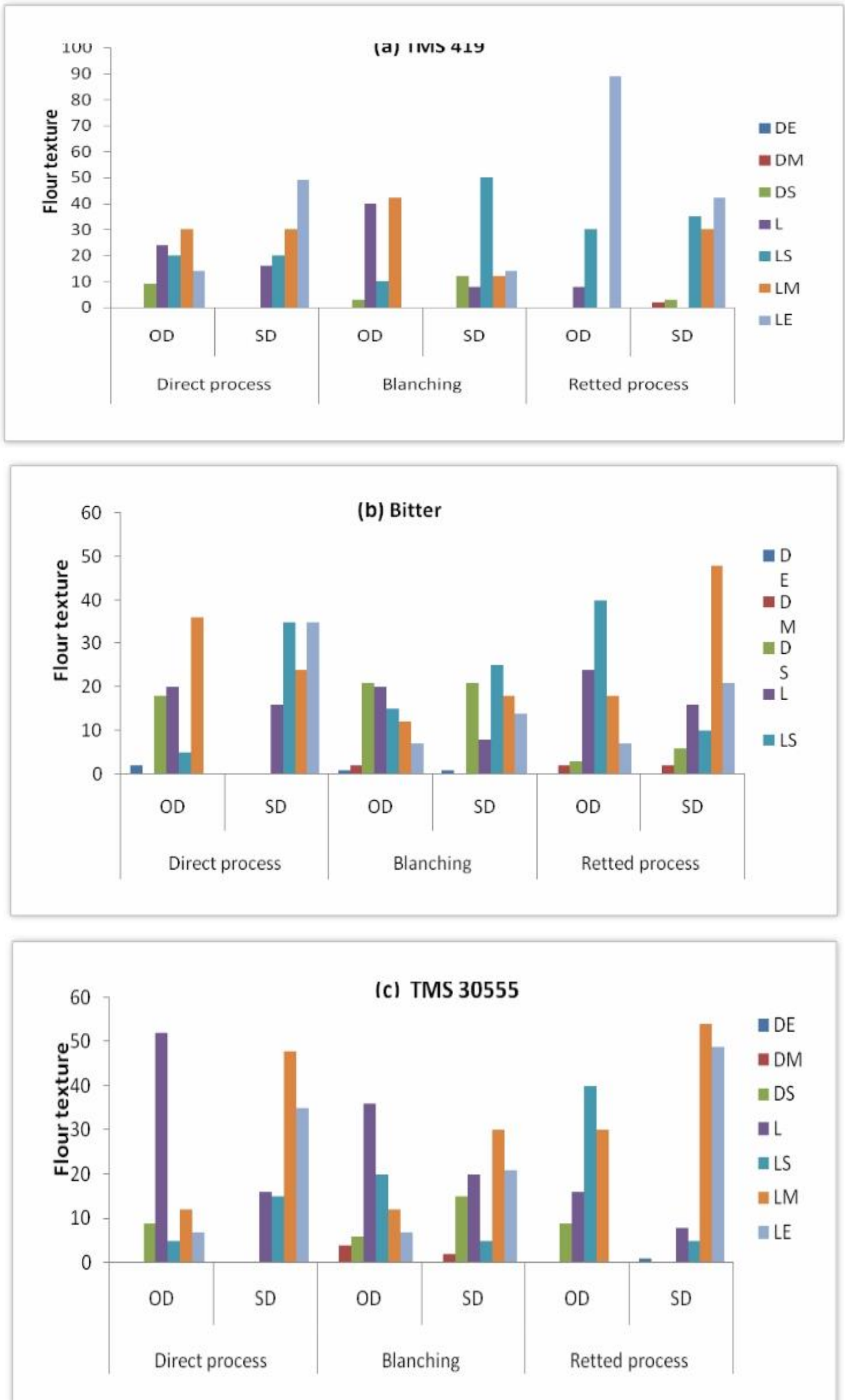

Figure 1 (a,b,c). Effect of oven (OD) and sun drying (SD) methods on (a) TMS 419 (b) Bitter carotene (c) TMS 30555 Flour texture.

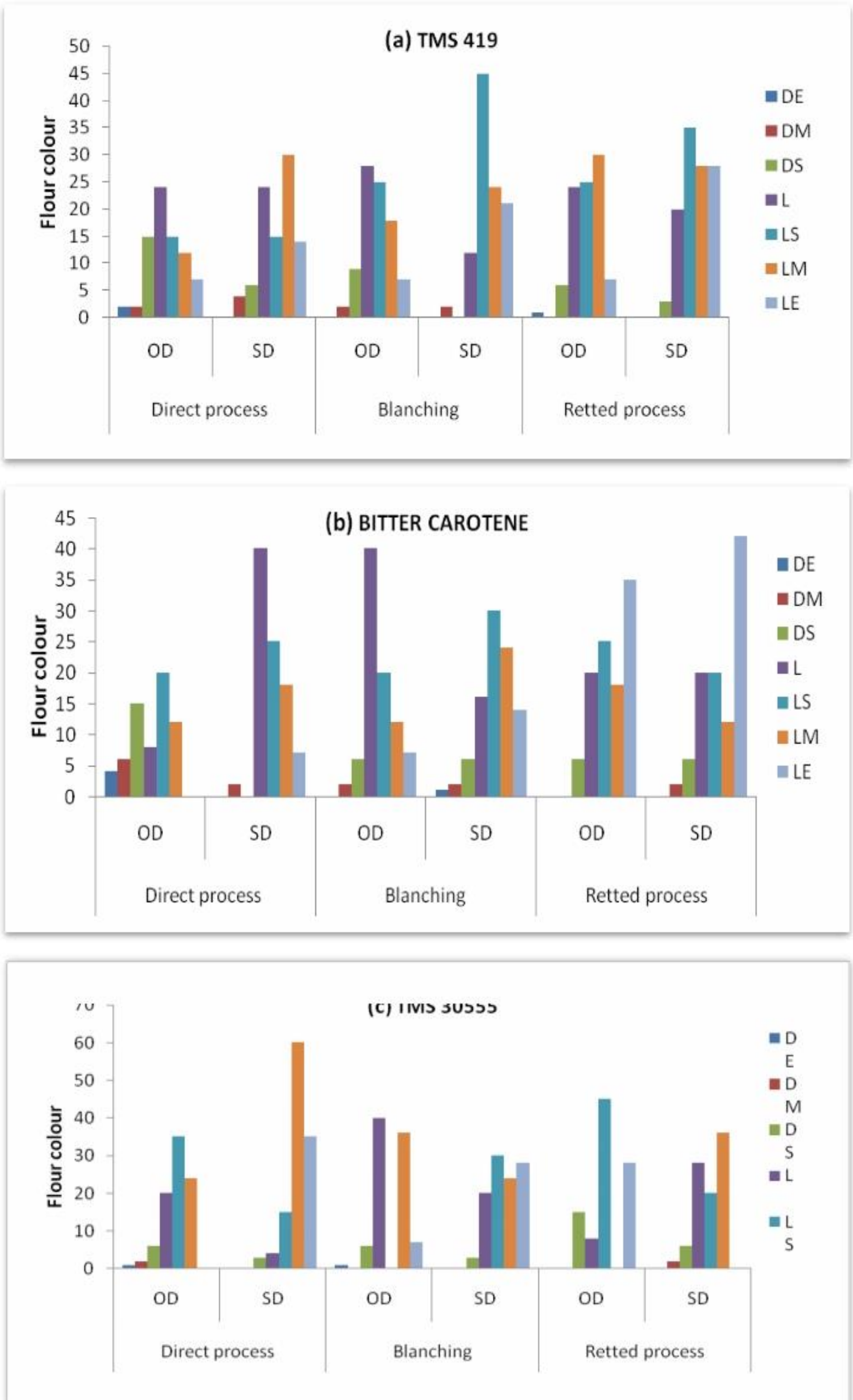

Figure 2 (a,b,c). Effects of oven and sun drying method on flour colour of {(a) TMS 419 (b) Bitter carotene (c) TMS 30555} cassava varieties.

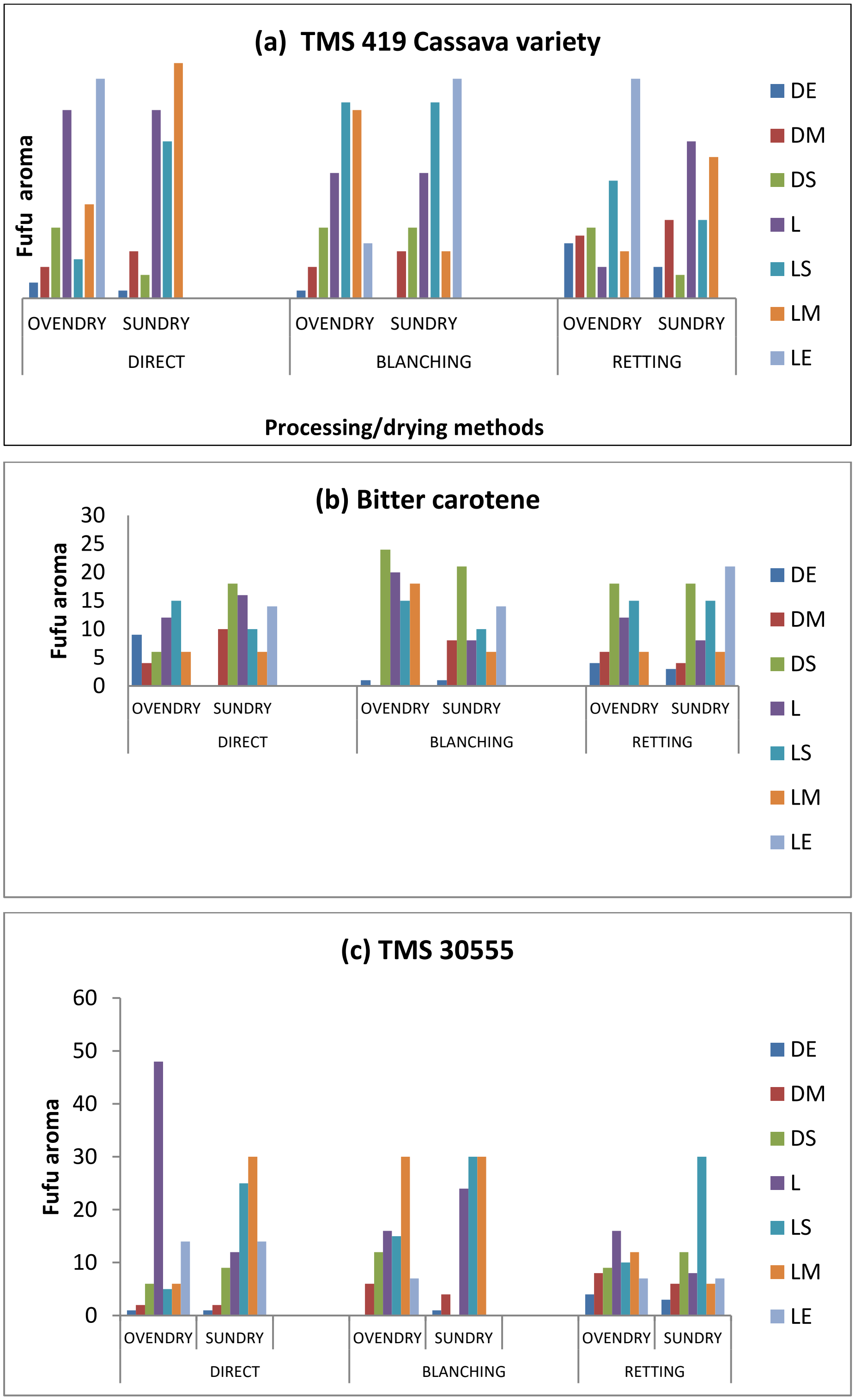

Figure 3 (a,b,c). Effect of drying methods of Fufu aroma obtained from TMS 419, Bitter Carotene and TMS 30555 cassava varieties

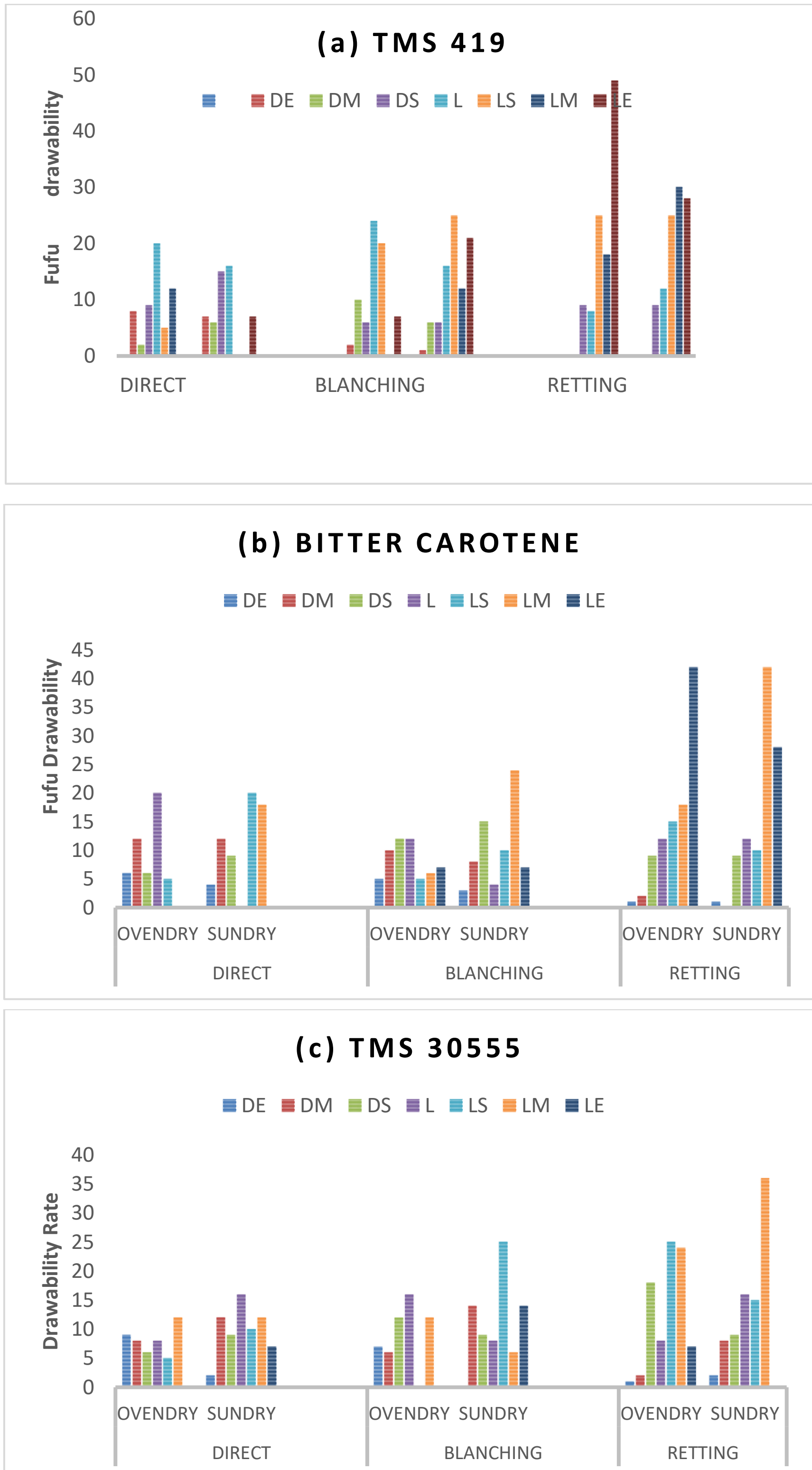

Figure 4 (a,b,c). Effect of oven and sun drying methods on (a) TMS 419 (b) Bitter carotene (c) TMS 30555 fufu drawability rate.

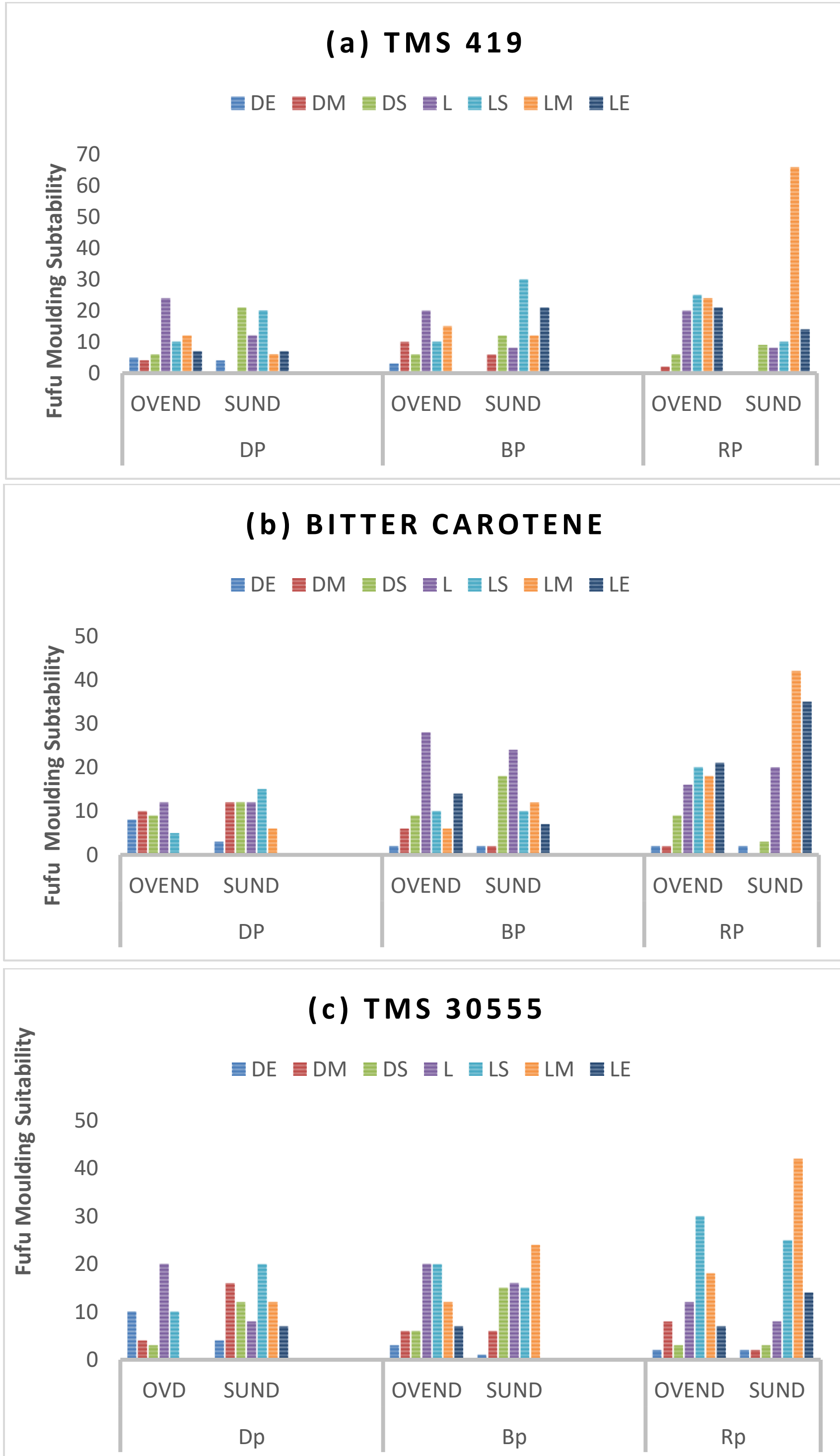

Figure 5 (a,b,c). Effect of oven and sun drying methods on (a) TMS 419 (b) Bitter carotene (c) TMS 30555 fufu moulding rate.

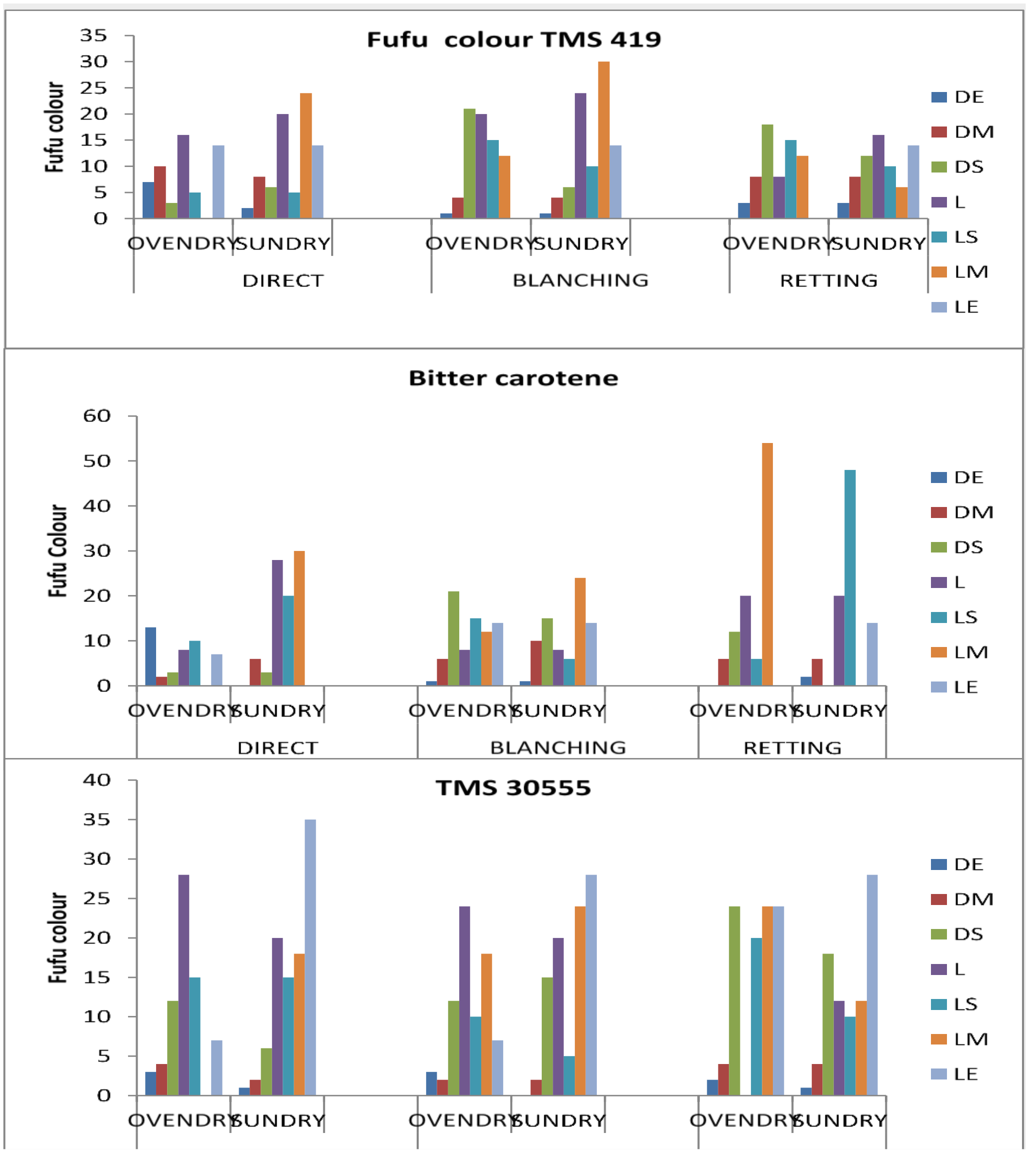

Figure 6 (a,b,c). Effect of oven and sun drying methods on (a) TMS 419 (b) Bitter carotene (c) TMS 30555 Fufu colour.

3.3. Fufu aroma

Across the various processing methods, a more acceptable fufu aroma was obtained with the sun dried TMS 419. ANOVA result shows significant difference ($p \leq 0.05$) in the aroma of sun dried cassava against that obtained from the oven drying (Figure 3a).

However, for bitter carotene and TMS 30555 cassava varieties, result obtained across the processing methods (blanching, retting, and direct) did not vary (Figure 3b and 3c) in aroma.

3.4. Draw-ability

In direct and retted processing methods the drawability index of fufu obtained with the oven dried method were more acceptable but in blanching method sun dried recorded a higher degree of acceptable level of the fufu drawability (Figure 4a).

In bitter carotene, the oven and sun drying methods did not show any degree of variability with respect to direct methods of processing but in the blanching method of cassava flour processing, more of the assessors liked moderately fufu drawability rate, obtained with sun drying. However, in the case of retted method of processing fufu drawability index obtained with use of oven drying was extremely liked more than that obtained from flour processed through sun drying.

In TMS 419 and TMS 30555 the observed difference in drawability index was significant at $P > 0.05$, but for bitter carotene drying methods did not differ significantly in drawability index of the fufu quality as shown in Figures 4a and 4b.

3.5. Moulding suitability rate

Rate of suitability for moulding for the oven and sun dried method did not differ significantly across direct and blanching methods of processing. However, TMS419 recorded a higher degree in the sun drying methods with more assessors liking moderately fufu gotten from sun dried flour (Figure 5a).

Across the different processing methods, the retted processing was more suitable for moulding in bitter carotene cassava variety (Figure 5b). A similar result was also obtained for the oven dried and sundried methods in the retting technique of processing.

The observed difference with the sun drying methods of the retting treatment in TMS 419 differed significantly at $P > 0.5$. In bitter carotene and TMS 30555(5b and c) the observed difference in the retting method across drying processes also differed significantly ($P > 0.05$) with sun drying recording better degree of acceptance.

3.6. Fufu colour

Both in direct and blanching methods of processing, sun drying techniques recorded higher and better acceptable colour than oven drying for TMS 419. (Figure 6a).

Similarly, in bitter carotene (Figure 6b), fufu colour obtained from sun dried Cassava flour were more acceptable in the direct and blanching methods of processing but in the retted processing method, oven dried cassava flour recorded a more acceptable fufu colour over the sun drying method. This observed difference in degree of fufu colour acceptability were shown to be significant ($P > 0.05$).

In TMS 30555 cassava varieties, sun drying technique of processing gave higher and more acceptable fufu colour than oven drying across the direct and blanching methods of processing (Figure 6c). A similar result was obtained in fufu colour of the retting processing technique. This again was shown to be significant at $p > 0.05$.

4. Discussion

Drying is a food products preservation method that is known to aid reduction of moisture level and inhibit the growth of bacteria, yeasts, and mould. In this study result obtained shows that sun drying had remarkable effect on flour texture and colour obtained. This could be because of the nature of the carbohydrate, protein and fat present in the cassava variety and their breakdown process. Under heat carbohydrate, fat and protein lose consistence and breakdown into forms that cannot produce their normal binding effects. Such breakdown process can produce remarkable change in colour and texture. Earlier, Isirima, et al (2020) reported that sundried cassava flour product recorded a higher % protein value than oven dried products. Starch quality in cassava and breakdown process varies with cassava varieties depending on source and degree of heat applied. Carbohydrates undergoes caramelization or gelatinization process depending on nature and degree of heat received. The reported better and acceptable flour texture of the TMS 419 and bitter carotene cassava varieties with sun drying method could be associated with ambient temperature of the drying environment, leading to gradual drying of the fat, protein, and starch components of the cassava variety. Generally, flour obtained from TMS 419 cassava varieties is of high preference in bread making than other cassava variety, due to high carbohydrate quality and low HCN level (Isirima et al., 2018).

Acceptable flour colour obtained herein, with sun drying of TMS 419, bitter carotene and TM 30555 could be linked with gradual drying, resulting from uniform temperature and air circulation in the sun drying process. When starchy foods are dried under high temperature (oven) 'Case hardening'' occurs, such situation is likely to affect colour and texture of the resultant product.

Fufu consumption, although low in Northern Nigeria, is very common among people in homes and hotels across East, West, and Southern Nigeria. Better fufu aroma observed with use of sun drying method to process TMS 419 cassava flour could be attributed mainly to a combination of varietal effect and drying method employed. Producing fufu with an acceptable aroma, often referred as odorless fufu, is no doubt an enhancement to fufu preparation. Fufu drawability rate simply describes the degree of stickiness of the dough that enhances ability of the fufu to be rolled into a ball that can be steep into soup and subsequently swallowed with ease, without chewing. Though, Isirima et al (2018) in a separate study had reported that use of retting (fermentation) method to process the cassava varieties, produced better fufu drawability rate, the result of this study isolated the blanched/ sun dried bitter carotene cassava variety as having a higher and acceptable draw-ability rate, than the oven drying technique. The heat usually generated with the blanched cassava product, later subjected to sun drying process must have altered the nature of the starch in the studied cassava variety leading to production of fufu with the accepted degree of stickiness as indicated in this study. Carbohydrate in cassava vary in forms according to variety and treatment given to produce a food stuff. Each form of starch and sugar reacts differently when subjected to heat. Generally, starch when heated in water medium absorbs moisture and swells, a process known as gelatinization. Likely, the sun dried, bitter carotene, TMS 419 and TMS 30555 flour produced a better gelatinization than the oven dried products process as the flour were steeped into boiling water and stirred vigorously to produce fufu. This probably accounted for acceptable draw quality of the fufu obtained. Higher degree of gelatinization process in TMS 419 possibly lead to the higher rate of acceptability of the fufu obtained from the cassava variety. Ability of fufu to be rolled into a small boll capable of passing through the consumers oesophagus with ease, with or no chewing process, is an important index that consumers consider in accepting fufu as food suitable for consumption. Moulding with ease (ability to mould into boll) is an important factor for consideration among fufu consumers. Higher and better drawability status of TMS 419 and acceptable moulding suitability rate of the variety as indicated in the study is related to starch type and gelatinization propensity. Poor rate of gelatinization will lead to unacceptable drawability and poor moulding ability of the resultant fufu.

5. Summary and conclusion

Drying techniques employed in the study were oven and sun drying. The sensory evaluation of fufu prepared with the cassava flour was determined using 20 (twenty) panelists consisting of staff and students of the Department of Agricultural Education of the Federal College of Education (Technical), Omoku. TMS 419 and bitter carotene showed an acceptable flour texture with use of sun drying processing technique. Acceptable and better flour colour were obtained with the use of sun drying technique to process TMS 419, bitter carotene and TMS 30555. This could be attributed to gradual breakdown of the protein and fat and adequate caramelization process of the carbohydrate components contained in the food product. Acceptable fufu colour obtained in this study is more or less the direct effect of the sun drying processing technique. Better fufu aroma recorded in the study with the use of sun drying technique to process TMS 419 cassava variety, could be attributed to response of the carbohydrate contained in the cassava variety to sun drying treatment applied. In terms of fufu draw-ability, sun dried bitter carotene, TMS 419 and TMS 30555 produced a better and acceptable fufu drawability ratio than oven dried. Higher and better drawability status of TMS 419 and acceptable moulding rate recorded in the study is associated with the sun drying technique of processing.

From the is study, it could be concluded that sun drying method of moisture reduction (TMS 419 and bitter carotene) recorded more acceptable flour texture and colour. Sun drying of TMS 419, bitter carotene and TMS 30555 recorded acceptable fufu colour. Better fufu aroma, draw-ability and moulding rate were obtained with the use of sun drying technique to process TMS 419, bitter carotene, and TMS 30555, irrespective of the of the processing methods (direct, blanching and retting) employed.

5.1. Recommendations

Since acceptable flour texture, colour, fufu colour, draw rate, and aroma were obtained with sun drying processing methods, we do hereby recommend that the sun drying method of processing be adopted to achieved flour and fufu with best consumer preference. This recommendation is strictly restricted to the tested cassava varieties and treatments employed in this study with flour/fufu as the target food product. Other cassava varieties not captured in this study may produce results similar or contrary to the results documented herein.

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