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EFFECTS OF COOKING AND FRYING ON ANTIOXIDANTS PRESENT IN SWEET POTATOES (IPOMOEA BATATAS)

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ABSTRACT

This study determines the effects of cooking and frying on the antioxidants (vitamin A, vitamin C and vitamin E) present in sweet potato. The variety of sweet potato used is the orange type that was free from diseases and defects. Portions of prepared sweet potato samples were fried under a regulated temperature of 70^{o}C for different time intervals of 10 minutes and 15 minutes while dome other portions were cooked at 100^{o}C for 10 minutes, 15 minutes and 20 minutes. Analysis of vitamin A, vitamin C and vitamin E contents was carried out on raw, fried and cooked sweet potato samples using the nutritional guidelines of Association of Official Analytical Chemists. Differences between the mean values of the treatments were determined by the least significant difference (LSD) test at 5% level of significance. There were significant differences in vitamin A, vitamin C and vitamin E contents of cooked and fried sweet potato. More of the nutritional contents, especially vitamins A and C were retained in cooked sweet potato than in fried one. Cooked sweet potato is recommended for the elderly and small children since it contains more vitamin A which enhances good eyesight.

Keywords: Antioxidants, Cooking, Frying, Proximate composition, Sweet potatoes

INTRODUCTION

The inability to determine the effects of cooking and frying on the antioxidants present in sweet potato has been a major obstacle to the development of commercially available products in Nigeria.Sweet potato (*Ipomoea batatas*) is a hardy and nutritious staple food crop, which is grown throughout the humid tropical and subtropical regions of the world, from sea level to 2,700 m altitude (O'Sullivan et al*.,* 1997). Sweet potato is a good source of fibre which plays a favourable role in reducing blood cholesterol level. Sweet potato also contains a significant quantity of the anti-oxidant nutrients β-carotene (derived from vitamin A), vitamin C and vitamin E; thus, its consumption inhibits the formation of free-radicals which have been implicated in the development of coronary heart disease (Woolfe, 1992). Both β-carotene and vitamin C are very powerful antioxidants that work in the body to eliminate free radicals. Free radicals are chemicals that damage cells and cell membranes and are associated with the development of conditions like atherosclerosis, diabetic heart disease, and colon cancer. Also these nutrients are anti- inflammatory, meaning they can help in reducing the severity of conditions where inflammation plays a role, such as asthma, osteoarthritis and rheumatoid arthritis. In addition, sweet potatoes are a good source of vitamin B_6, which is needed to convert homocysteine, an interim product created during an important chemical process in cells called methylation, into other benign molecules and this helps to reduce the risk of stroke or heart attack (Meteljan, 2006; Lorna, 2009).

Two of the commonest ways of consuming sweet potatoes are cooking and frying. These methods of processing sweet potato for consumption make sweet potato palatable but they also have adverse effects on the proximate compositions of the sweet potato. Methods of cooking and frying sweet potatoes vary in different countries. Common methods of cooking include baking, roasting, frying, grilling, barbecuing, smoking, boiling, steaming and braising. Cooking can be detrimental and beneficial to the nutrient contents of food (Chukwu et al., 2010). Although cooking results in the loss of some nutrients, it can also convert other nutrients into a form that would otherwise not be used by the body. Cooking produces desired texture, flavour and palatability in food. Starchy foods such as potatoes, corn, beans and lentils are made more digestible by cooking; the nutritive value of the protein in legumes such as soya beans, lima beans, lentils and chick peas is also improved by cooking.

The common methods of frying include shallow frying, sautéing, stir frying and deep-fat frying in vegetable oil or melted animal fats. Food frying is a common process in the food industry used to enhance the overall quality, texture and flavour of snack foods, doughnuts, French fries and poultry products (Chukwu, 2009). Frying is a unit operation which involves the immersion of food products in hot oil (175˚C) until the desired product attributes are obtained, from creating the proper appearance to fully-cooked product. During the process, moisture in the outer surface of the food migrates into the oil in the form of steam and oil is absorbed by the food product. The type of oil, temperature of the oil, duration of cooking and food product surface (coating) greatly affect the food's final texture, flavour, and quality attributes (Tareke et al., 2000).

There is rapid rise in the surface temperature of food placed in hot oil. As the product's internal moisture is vaporized into steam, the surface begins to dry. A crunchy crust forms on the outside as the plane of evaporation moves inside the food (Fellows, 2009) and hot fat begins to penetrate the food. The crust prevents large amount of fat from passing through to the inside of the product and a film of oil surrounds the product upon removal from the fryer. The thickness of the film controls the rate of heat and mass transfer. According to the condensation mechanism for oil uptake, as vapour escapes from food frying in hot oil, an overpressure is created inside the food's pores. This prevents the oil from penetrating the food. This barrier of escaping steam continues until just after the food is removed from the oil (Mellema, 2003).

Frying which is a food processing method has adverse effects on the proximate compositions of roots and tubers and every piece of food fried in it. The choice of frying fat depends on many factors such as availability, price, frying performance, flavour and stability of product during storage. As deep fat frying is normally carried out at high temperatures (between 160°C and 180°C) and in the presence of air and moisture, these frying oils and fats will undergo physical and chemical deterioration which will affect their frying performance and the storage stability of the fried products (Fauziah et al., 2000). In addition, highly oxidized oils may also produce polyaromatic hydrocarbons that are thought to have a carcinogenic effect (Rahman et al., 2007).

Roots and tuber crops such as sweet potatoes, cassava and yam reduce in nutritional compositions when cooked or fried and it has been observed that the reduction is drastic; thus increasing the health hazards to man. Vitamins and minerals of roots and tubers are easily destroyed by cooking or frying (Blumenthal, 1991). Heat which is applied during cooking and frying does not have an immediate effect on the food cooked or fried; it takes time for heat to make the desired effect that is required of it on food generally. In general, heat has adverse effects on food including denaturation of proteins, coagulation of lipids and breakdown of starch which is the source of carbohydrates into simpler components when cooked or fried for a long period of time (Traka and Mithen, 2009). The objective of this study is to determine the effects of cooking and frying on the antioxidants (vitamin A, vitamin C and vitamin E) present in sweet potato.

MATERIALS AND METHODS

Sample Procurement

The samples of sweet potatoes (Figure 1) for determining the effects of cooking and frying on antioxidants present in sweet potatoes and vegetable oil used for the frying activity were purchased from Kure Market in Minna, Niger State, Nigeria. The variety of sweet potatoes used in this study is the orange sweet variety that was free from diseases and defects.

Fig. 1: Raw sweet potatoes

Sample Preparation

The sweet potatoes were cleaned and washed. They were sliced into equal parts of 1cm thickness with the use of a sweet potato slicer. The sliced sweet potatoes (10.5 kg) were divided into three unequal portions of 1.5 kg, 4.5 kg and 4.5 kg. The first portion (1.5 kg) was sub-divided into three equal parts of 0.5 kg and labelled R_1, R_2, R_3 (raw sample to serve as control). The second portion (4.5 kg) was divided into three equal parts of 1.5 kg and each part was sub-divided into three equal portions of 0.5 kg. Each of the 0.5 kg portions was fried under a regulated temperature of 70 ^oC for different time intervals of 10 minutes (F_{10}) and 15 minutes (F_{15}). The third portion (4.5 kg) was also divided into three equal parts of 1.5 kg and each part was sub-divided into three equal portions of 0.5 kg. Each of the 0.5 kg portions was cooked at 100^oC for 10 minutes (F_{10}), 15 minutes (F_{15}) and 20 minutes (F_{20}).

Vitamins A, C and E were determined on the raw, fried and cooked sweet potato samples using the AOAC (2005) nutritional guidelines. The nutritional analyses for the vitamins A and C were carried out in the Central Services Laboratory, National Cereals Research Institute, Baddegi, Bida, Niger State, Nigeria. The experiments were completely randomized. Analyses for antioxidants in the sweet potato samples were replicated three times. Results presented are mean values ± standard error of mean (SEM). SPSS 15.0 for Windows was used for all the analyses including the error bar charts. Differences between the mean values of the treatments were determined by the least significant difference (LSD) test at 5% level of significance.

RESULTS AND DISCUSSION

The test of significance for antioxidant compositions of raw, fried and cooked sweet potatoes are presented in Table 1 while the error bar charts for vitamins A, C, and E are presented in Figures 2, 3 and 4, respectively. Figures 2, 3 and 4 show the variations in vitamins A, C, and E, respectively in raw, fried and cooked sweet potatoes.

- R represents the raw sweet potatoes
- F_{10} represents sweet potatoes fried for 10minutes
- F_{15} represents sweet potatoes fried for 15minutes
- C_{10} represents sweet potatoes cooked for 10minutes
- C_{15} represents sweet potatoes cooked for 15minutes
- C_{20} represents sweet potatoes cooked for 20minutes

Table 1: Test of significance for antioxidant compositions in raw and treated sweet potatoes (mean ± standard error of mean)

Antioxidants	Fried			Cooked		
(mg/100)	R	F_{10}	F_{15}	C_{10}	C_{15}	C_{20}
Vitamin A	4.99^{d} ±0.09	6.52^{bc}±0.26	6.18^{cd}±0.10	8.13^{a}±0.57	8.13^{a}±0.57	7.77^{ab}±0.29
Vitamin C	0.50^{c} ±0.09	0.67^{abc}±0.09	0.65^{bc}±0.01	0.80^{ab}±0.09	0.80^{ab}±0.09	0.89^{a}±0.07
Vitamin E	0.35^{a} ±0.01	0.33^{ab}±0.01	0.32^{abc}±0.01	0.29^{cd}±0.01	0.29^{cd}±0.01	0.26^{d}±0.02

Values on the same row with different superscripts are significantly different from each other ($P \leq 0.05$) while the values that are of the same superscript are not significantly different from each other ($P > 0.05$).

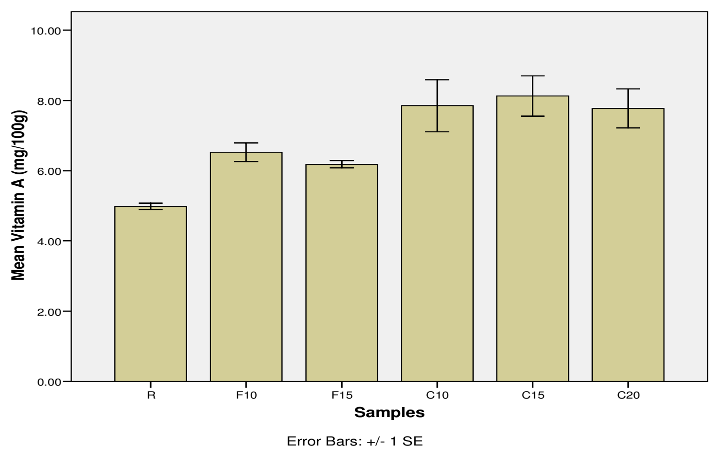

Fig. 2: Bar chart showing the variation in mean vitamin A content (mg/100g)

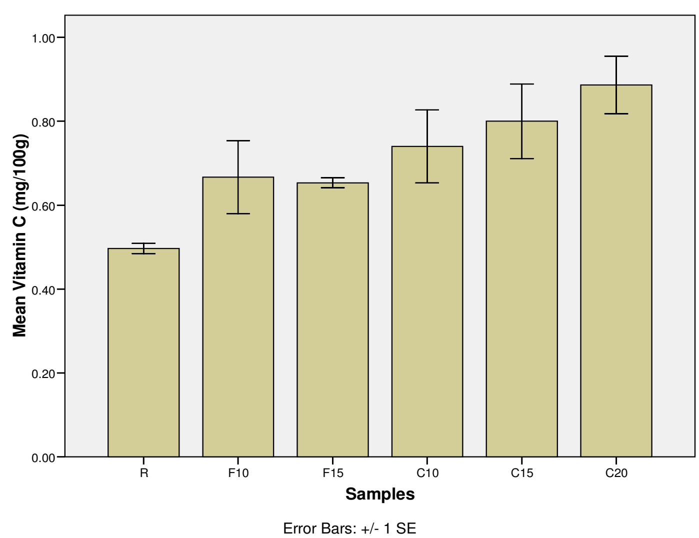

Fig. 3: Bar chart showing the variation in mean vitamin C content (mg/100g)

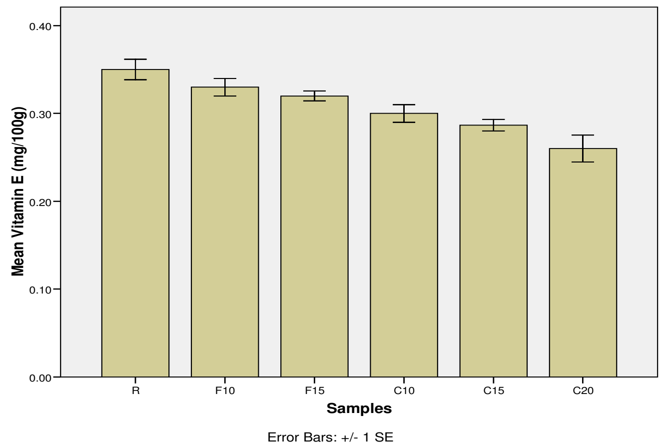

Fig. 4: Error bar chart showing the variation in mean vitamin E content (mg/100g)

The results from the test of significance (Table 1) for the raw, fried and cooked sweet potatoes showed that there was no significant difference in the mean vitamin A contents of sweet potato cooked for 10 minutes and that cooked for 15 minutes. However, the vitamin A contents of sweet potatoes fried for 10 minutes and that fried for 15 minutes were significantly different from those of sweet potatoes cooked for 10, 15 and 20 minutes. They were also significantly different from the vitamin A contents of raw sweet potatoes.

The vitamin A content of C_{15} was not significantly different from C_{10} and C_{20} but significantly higher than F_{10}, F_{15} and R. The vitamin content of C_{10} and C_{20} were not significantly different from F_{10} but significantly different from F_{15} and significantly higher than R, which was not significantly different from F_{10}.

The vitamin C content for C_{20}, C_{10}, C_{15} and F_{10} were not significantly different from each other but C_{20} was significantly higher than F_{15} and R. Samples C_{10}, C_{15}, F_{10} and F_{15} were not significantly different from each other but they are significantly higher than R, except F_{10} and F_{15} which were not significantly different from R.

The vitamin E content of samples R, F_{10}, and F_{15} were not significantly different from each other but R was significantly higher than C_{10},C_{15} and C_{20}. The vitamin E content of F_{10} was not significantly different from F_{15} and C_{10} but significantly higher than C_{15} and C_{20}. The vitamin E content of F_{15}, C_{10} and C_{15} were not significantly different from each other but significantly higher than C_{20} but C_{15} was significantly different from C_{20}.

CONCLUSION

Based on the results from this study it was concluded that there were significant differences in vitamin A, vitamin C and vitamin E contents of cooked and fried sweet potato. More of the nutritional contents, especially vitamins A and C were retained in cooked sweet potato than in fried one. As a result, cooked sweet potato is recommended for the elderly and small children since it contains more vitamin A which enhances good eyesight.

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