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Studies on black tea production from fresh roselle calyxes

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Abstract

Black tea was produced from fresh Roselle calyxes adopting the general procedure for black tea production from tea plants. Different fermentation hours were used and the proximate analysis, vitamin C content, pH and mineral composition (iron, Calcium and Phosphorus) were determined. Roselle black tea produced met the standards for black tea and generally had an increase in nutritional content when compared to the initial nutritional content of the fresh Roselle calyxes. Production of black tea from Roselle calyxes could be exploited as a means of preserving, adding value to the calyxes and increasing the nutritional benefits of Roselle calyxes.

Introduction

In recent years the use of pleasant red colored calyxes of the *Hibiscus sabdariffa* (Roselle) plant pharmaceutical manufacturers. Roselle calyxes have thus been identified to be a tropical plant of considerable economic potential not only in extensive local and regional markets but also in international markets. Roselle calyxes are popularly known for their use in making cold and hot beverages in many of the world's tropical and subtropical countries. Traditional use of Roselle calyxes spans from its use in remedies for various illnesses to food uses such as stewing, sauce or filling for tarts or pies; and also for processing to jam, jelly, syrup, wine, ice cream and flavors since it possesses 2-3% pectin (Morton, 1987). Other not too common uses to which these calyxes are put include the production of wine and food colorants or emulsions for carbonated drinks and synthetic dyes.

True teas come from the young leaves of the tea plant which is a bush. The term "tea" is somewhat also used for hot water extract of other plant materials such as jasmine (Potter and Hotchkiss, 1996). These are often known as herbal teas, a class of teas which Hibiscus sabdariffa belongs. In our health conscious society, the consumption of herbal teas has shown a continuous increment. Fresh or dried Roselle calyxes are commonly processed traditionally into tea which is then consumed by steeping or boiling. Generally around the world fresh or dried calyxes are available in health stores and there are various traditional recipes for brewing these products (Congo cookbook, 2004). Main importers of Roselle calyxes in the United States are Celestial seasonings and Lipton, both tea companies (Plotto, 2001).

Despite this common use of Roselle calyxes, Thailand is the only country that produces and adds value to Roselle calyxes by cutting and sifting into tea bag size because of its superior reputation of cleanliness. Other producers find it difficult to do so as once processed Roselle calyxes are almost impossible to clean, hence it is easier to sell whole calyxes (Plotto, 2001). This shows that it is possible to exploit the potentials of processing Roselle calyxes to tea alongside its other uses. There are however no standardized procedures for black tea production from Roselle in literature. This paper presents the results of preliminary studies on the production of black tea from Roselle calyxes cultivated in Nigeria.

Materials and Methods

Determination of initial quality of fresh Roselle calyxes

Fresh dark red Roselle calyxes were obtained from the Roselle plant cultivated on the Teaching and Research farm of Obafemi Awolowo University, Ile-Ife, Nigeria. Harvested calyxes were stored in the freezer and brought out for use 24hrs before

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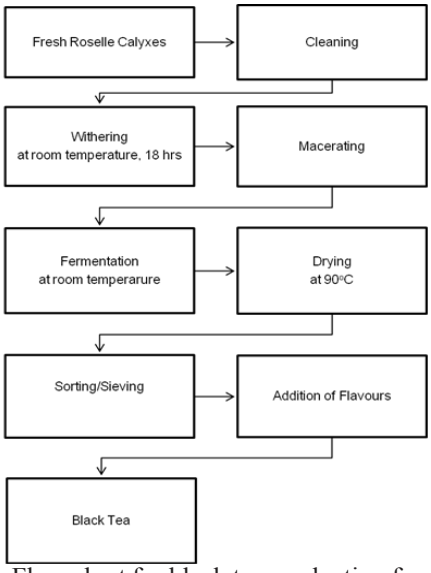

Figure 1. Flow chart for black tea production from Roselle calyxes

the experiment. Moisture content of the calyxes were obtained by adopting the procedure used for medicinal and herbal plants (Soysal and Oztekin, 2001; Park *et al.*, 2002). This involved drying triplicate samples (10g) of the calyxes in an oven at a temperature of 105°C and drying to constant weight. Other constituents of proximate analysis (ash, crude fibre, protein, ether extract and carbohydrate) and Vitamin C content of the fresh calyxes were obtained using standard methods (AOAC, 1990; Jacobs, 1999). Mineral composition (Phosphorus, Iron and Calcium) of the fresh calyxes were also obtained using an atomic absorption spectrophotometer. The pH of the calyxes was determined by dissolving 2 g of the fresh Roselle sample in 10ml of distilled water and then reading the pH value with the use of a digital pH meter (CD70, S/N 802, Linton Cambridge).

Procedure for the production of black tea from fresh Roselle calyxes

Roselle calyxes were processed into tea using the general method for black tea production shown in Figure 1. This involved cleaning the calyxes manually to remove debris, stalks, stones and other impurities and then withering by spreading them thinly on wire nets for 18 hours in a room. The moisture content of the calyxes after withering was checked to ensure it was in the range (55-70%) recommended in the literature (Wilson, 1999). For experimental purposes the withered calyxes were macerated using a laboratory mortar and pestle and macerated calyxes were then kept in an incubator set at 27°C to be fermented. Samples were fermented for 3, 4 and 5 hours, respectively. During this process the calyxes were kept moist by wetting at intervals. Fermented calyxes were dried in an oven set at about 90°C.

Figure 2. Black tea produced from fresh Roselle calyxes

Drying was continued until the moisture content of the calyxes was reduced to about 2.5- 3.5% (this took about 14 hours). The dried calyxes were sorted by passing through sieves to ensure their particle size was between 0.5 mm and 0.75 mm and dried lime and orange peels were added to the processed calyxes as flavors. The Roselle black tea produced was handled as minimally as possible and packed in tea bags. The same procedures used for determining the quality of fresh calyxes were also used for analyzing the Roselle black tea produced at different fermentation times.

Results and Discussion

Proximate composition of fresh Roselle calyxes and black tea produced

Black tea (Figure 2) was successfully produced from fresh Roselle calyxes using the flow chart in Figure 1. Results of proximate analysis of fresh calyxes and black Roselle tea produced using different fermentation times are presented in Table 1. The moisture content of the fresh Roselle calyxes used in the tea production was found to be 86.01%, wet basis. This agrees with the findings of other researchers (Duke, 1983; Babalola *et al*., 2001) who reported the moisture content of wet calyxes to be from 85.3 g to 86.5 g per 100 g. There was significant differences (at the different fermentation times) for moisture content of the black tea produced which ranged from 4.45 to 8.87%, wet basis; although this range is within the value of 3.93 - 16.20% for black tea reported in literature. According to Jacobs, 1999 an average moisture content of 5.94% is preferred for black tea; moisture content of Roselle black tea fermented for 3 and 4 hours, respectively was within this preferred range.

The proximate composition of fresh calyxes and black tea produced using different fermentation times showed that the black tea produced had higher protein, ash crude fibre and carbohydrate contents than that of fresh calyxes. The increase in proximate composition

Table 1. Proximate composition of fresh calyxes and black Roselle tea produced

Proximate composition (%)	Fermentation time (Hours)			
	3	4	5	Fresh calyxes
Moisture content	5.94^{b}	4.50^{c}	8.75^{a}	85.84
Ash	5.46^{a}	5.21^{a}	5.09^{a}	1.04
Protein	11.03^{a}	11.46^{a}	10.61^{a}	3.31
Ether extract	1.57^{a}	1.26^{b}	1.00^{c}	0.94
Crude fibre	14.25^{a}	13.21^{b}	13.39^{b}	3.71
Carbohydrate	61.75^{b}	64.37^{a}	61.16^{c}	5.16

Values with the same superscript along the same row are not significantly different ($p < 0.05$)

Table 2. Mineral and vitamin C contents of fresh calyxes and black Roselle tea produced

Amount (mg / 100 g)	Fermentation time (Hours)			
	3	4	5	Fresh calyxes
Phosphorus	3.87^{b}	4.18^{a}	4.30^{a}	1.43
Calcium	2.27^{b}	2.86^{a}	2.94^{a}	3.40
Iron	26.70^{c}	36.00^{b}	45.10^{a}	128.00
Vitamin C	15.1^{a}	13.80^{b}	13.20^{b}	15.70

Values with the same superscript along the same row are not significantly different ($p < 0.05$)

was significant for ether, crude fibre and carbohydrate contents of the tea produced. These increases maybe due to the fact that the microorganisms that fermented the calyxes may have secreted extra cellular enzymes leading to increases in the nutritional content of the tea produced. A similar observation was made by Ojokoh *et al.* (2002); Adanlawo and Ajibade (2006) in the study of the fermentation of Roselle calyxes neutralized with Trona. Ash content in tea is generally reported to fall between 5- 6%. For black tea an average total ash content of 6.27 was given by Jacobs (1999). Ash contents of the Roselle black tea produced at the different fermentation times fell with this range.

Mineral composition and vitamin C contents of fresh Roselle calyxes and black tea produced

The mineral composition and vitamin C content of fresh calyxes and the black tea produced is presented on Table 2. Generally, there was a significant increase in the mineral composition of the tea produced as fermentation time increased. When these values were compared with the initial values of the fresh calyxes, however, there was a noticeable increase in the phosphorus contents of the tea produced while there was a reduction in calcium, vitamin C and iron contents of the tea produced. However, analysis from Duncan's grouping showed that Vitamin C, phosphorous and calcium contents of the black Roselle produced by fermenting for 4 and 5 hours were not significantly different. Vitamin C is easily destroyed by oxidation, especially at high temperatures and quite sensitive to air, light and heat; this could explain its reduction as fermentation time increased during the black tea production. Areoyeun *et al.* (2005) also reported an increase in calcium content and decreases in iron and vitamin C contents of wine produced from fermented Roselle calyxes.

pH of fresh Roselle calyxes and black tea produced

The pH value for fresh calyxes was 2.19 while pH for Roselle tea produced by fermenting for 3, 4 and 5 hours was 2.25, 2.46 and 2.50, respectively. Zaiton *et al*. (2009) gave pH values of 2.56 - 2.60 for unfermented Roselle tea. It was observed that there was a slight increase in the pH of the tea produced from the different fermentation times, with tea produced by fermenting for 4 and 5 hours being significantly different (using Duncan's ranking) from the tea which was produced by fermenting for 3 hours. This increase could be due to the products of fermentation formed at the different fermentation times during processing of the calyxes to tea. Mohammed and Yagoub (2007) attributed this increase in pH within the first 24 hours to be due to changes in species of fermentative microflora involved in the fermentation process. This increase could also be due to the flavors

(dried lime and orange peels) added to the tea. An increase of pH during fermentation of Roselle calyxes was also observed by Ojokoh *et al.* (2002).

Conclusion

Black herbal tea was successfully produced from fresh Roselle calyxes. The tea produced had a higher nutritional content than those of the fresh calyxes. Production of tea from Roselle can be exploited to preserve, add value to the calyxes and also make use of the additional nutritional advantages.

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