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EFFECT OF DIFFERENT PROCESSING METHODS ON PHYTOCHEMICALS AND NUTRITIONAL COMPOSITION OF BEETROOT.

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ABSTRACT

This work investigated the biochemical effects of processing methods on the nutritional profile of beetroot supplement diet. The beetroot samples were processed by roasting and boiling, then grouped into raw, roasted, and boiled. Standard methods were adopted for the determination of the phytochemical, proximate and trace mineral compositions of the raw, roasted, and boiled samples. The phytochemical compositions showed flavonoid (10.99, 9.56 and 7.39 %), Alkaloid (3.23, 4.01 and 2.99 %), Saponins (5.02, 3.84 and 4.85 %), Phenols (0.21, 0.15 and 0.23 %), Tannins (0.19, 0.08 and 0.07 %) respectively. Proximate analysis composition showed Moisture (70.23, 65.23 and 73.98 %), Crude protein (16.10, 14.00 and 9.80 %), Crude fat (0.52, 0.72 and 0.28 %), Ash (2.10, 3.21 and 1.89 %), Crude fibre (2.22, 2.56 and 2.01 %), Carbohydrate (8.53, 14.93 and 12.04 %) for the raw, roasted, and boiled samples respectively. The mineral analysis indicated Fe (1.20, 1.19 and 1.08 mg/kg), Zn (0.43, 0.54 and 0.77 mg/kg), Cu (0.04, 0.72 and 0.07 mg/kg), Mn (0.16, 0.14 and 0.03 mg/kg), Se (0.03, 0.13 and 0.11 mg/kg) for the raw, roasted, and boiled beetroot respectively. The result of this study suggests that processing methods could lead to nutrient loss of biomolecules.

Keywords: Beetroots, Phytochemicals, Proximate compositions, and trace minerals.

INTRODUCTION

Beetroot (*Beta vulgaris*) is classified as a herbaceous biennial plant from the genus *Chenopodiaceae* and has a wide variety of bulb colors ranging from yellow to red. There are different kind of beetroot; a few can be recognized by their shading yellow, white, pink, or dull purple. In any case, it's not just the drawing in look of beetroot that makes it a particularly engaging fixing, it is loaded with nutrients, minerals, and supplements, making it as probably the best food available (Mann, 2015). The bright red color of beetroots is based on high concentrations of betalains.

Betalain is used as a natural color for food industry, but also received growing awareness due to possible health benefits for people, especially their anti-inflammatory and antioxidant activities (Georgiev *et al.*, 2010; Zielinska- Przyjemska *et al.*, 2009). Other benefits include the prevention of lipid peroxidation (Reddy *et al.*, 2005), increased resistance to oxidation of low-density lipoproteins (Tesoriere *et al.*, 2003), and the effects of chemo protection (Zhang *et al.*, 2013). With the exception of betalains, small amounts hydroxycinnamic acid such as gallic, syringic, and caffeic acid and flavonoids have been identified (Kazimierczak *et al.*, 2014).

Deep-colored beetroots are popular for human consumption, both cooked and raw as a salad or juice.The nutritional value of beetroot has been widely claimed by researchers,but its value after mild processing has not been reported. Food processing methods have been reported to significantly affect the proximate and micronutrient contents of foods, but the extent to which this is applicable to different processing methods have not been determined for many foods.This work is therefore, aimed at determining the effects of processing methods on the nutritional profile of beetroot.

MATERIALS

Sample collection

The beetroot samples were gotten from Onitsha Main Market, Anambra State, Nigeria and were identified by a taxonomist in the Department of Botany Nnamdi Azikiwe University Awka, Anambra State.

Sample Processing

The beetroots were washed in running water and partitioned into three groups for various processing methods:

Group 1: Raw beetroot: This was cut into pieces, air dried for about fourteen days and ground.

Group 2: Boiled beetroot: This was cut into pieces, bubbled in water for 30 minutes at 90 – 100 ^{0}C. Subsequent to heating up, the water was sieved and disposed of. The bubbled beetroots were air dried for about fourteen days and ground.

Group 3: Roasted beetroot: This was cut into pieces, roasted for 30 minutes. After roasting, it was air dried for about fourteen days and ground.

Quantitative Phytochemical Analysis of the Beetroots

Flavonoid

Flavonoid content was determined by the method of Boham and Kocipai-

Abyazan (1974). Determination of alkaloids was by contrast (Harborne, 1973; Obadoni and Ochuko, 2001). Saponin concentration was determined by the method of Obadoni and Ochuko (2001). Phenols were determined by spectrophotometric method of (Edeoga *et al*., 2005), while the Follin Denis titrating method as depicted by Pearson (1974) was utilized for the determination of tannin content.

Proximate Analysis

Moisture content, ash content, crude fiber, and crude protein content, were performed according to the Association of Official Analytical Chemist (A.O.A.C., 1990).Carbohydrate was calculated by differentiation (A.O.A.C, 1990) by subtracting the total (g / 100g dry matter) of crude protein, crude fat, ash, and fiber from 100g. Calorie count determined by Atwater factor (FAO, 2003)

Mineral Analysis

Sample Digestion

The digestion method described by Sahrawat *et al*. (2002) was adopted for the sample digestion. Analysis of the trace metalswere carried out by Atomic Absorption Spectrometry (AAS).

Statistical analysis

The data were expressed as mean ± standard error mean (SEM). The Significance of differences among the group was assessed using one way and multiple way analyses of variance (ANOVA). The test followed by Dunnet's test p values less than 0.05 were considered as significance.

RESULTS

The quantitative phytochemical compositions of raw, roasted, and boiled beetroot

The results obtained from the quantitative phytochemical analysis of the raw, roasted, and boiled beetroot samples as shown inTable 1. It revealed that raw beetroot had the highest flavonoids, saponins, and tannins, whileroasted beetroot had the highest alkaloids. Boiled beetroot had the highest phenols.

Table 1:The phytochemical composition of raw, roasted, and boiled beetroot.

Phytochemicals (%)	Raw	Roasted	Boiled
Flavonoids (%)	10.99 ± 0.23	9.56 ± 0.03	7.39 ± 0.13
Alkaloids (%)	3.23 ± 0.17	4.01 ± 0.02	2.99 ± 0.12
Saponins (%)	5.02 ± 0.07	3.8 4± 0.11	4.85 ± 0.02
Phenols (%)	0.21 ± 0.11	0.15 ± 0.00	0.23 ± 0.05
Tannins (%)	0.19 ± 0.02	0.08 ± 0.00	0.07 ± 0.00

Values are mean ± standard deviations (n=3).

The proximate composition of raw, roasted, and boiled beetroot

Results obtained from the proximate composition analysis of raw, roasted, and boiled beetroot samples are presented in Table 2. The result indicated that boiled beetroot samples had the highest moisture content of which is followed by rawand then roasted beetroot. The crude protein content was found higher in raw beetroot, while boiled beetroot had the lowest protein contents. The highest crude fat content was found in roasted beetroot, while the lowest crude fat content was found in boiled beetroot. The highest ash content was found in roasted beetroot which is followed by raw beetroot and then boiled beetroot. Crude fibre content was found in the increasing order: roasted, raw and boiled beetroot. The highest carbohydrate content was found in roasted, while raw beetroot had the least carbohydrate content. Calculation using At water factor found that that among the processed beetroot sample, roasted beetroot had the highest energy value of 122.20 kcal of energy.

Table 2:The proximate composition of raw, roasted, and boiled beetroot

Parameter (%)	Raw	Roasted	Boiled
Moisture	70.23 ± 0.01	65.23 ± 0.01	73.98 ± 0.02
Crude protein	16.10 ± 0.01	14.00 ± 0.02	9.80 ± 0.01
Crude fat	0.52 ± 0.01	0.72 ± 0.01	0.28 ± 0.02
Ash	2.10 ± 0.02	3.21 ± 0.04	1.89 ± 0.01
Crude fibre	2.22 ± 0.02	2.56 ± 0.03	2.01 ± 0.03
Carbohydrate	8.53 ± 0.01	14.93 ± 0.01	12.04 ± 0.17
Energy Value (kcal)	103.2	122.20	89.88

Values are mean ± standard deviations (n=3).

The trace mineral composition of raw, roasted, and boiled beetroot

The trace mineral compositions analysis revealed varying concentrations of antioxidant minerals (Table 3). Roasted beetroot samplehad the highest Fe content, while the least Fe content was found in boiled beetroot.Boiled beetroot had the highest Zn content, while raw beetroot had the lowest Zn content. Cupper Cu contentwas found higher in roasted beetroot, whereas the least Cu content was found in raw beetroot sample and boiled beetrootwhich is not significant. The highest level of Mn was found in raw beetroot while the lowest was found in boiled beetroot. The highest Se contents were found in roasted beetroot compared to the raw and boiled beetroot.

Table 3:The trace mineral composition of raw, roasted, and boiled beetroot.

Mineral Composition (mg/kg)	Raw	Roasted	Boiled
Fe	1.20 ± 0.01	1.19 ± 0.11	1.08±0.02
Zn	0.43 ± 0.02	0.54 ± 0.06	0.77±0.01
Cu	0.04 ± 0.11	0.72 ± 0.02	0.07±0.01
Mn	0.16 ± 0.02	0.14 ± 0.02	0.03±0.01
Se	0.03 ± 0.01	0.13 ± 0.00	0.11±0.03

Values are mean ± standard deviation (n=3)

DISCUSSION

Phytochemicals are secondary metabolites produced by plants. Phytochemicals are of different types. Some are beneficial to man as antioxidant while some are poisonous or act as anti-nutrients. The findings of this study showed that the beetroot samples contained different phytochemicals in varying quantities. The most observable phytochemical presence was found in the raw samples.As shown in the result of the quantitative phytochemical analysis of the samples(Table 1). The results revealed that raw beetroot had the highest flavonoids , saponins, and tannins. The roasted beetroot had the highest alkaloids whileboiled beetroot had the highest phenols content. The difference in the composition of phytochemicals in the processed beetroot samples could be a reflection that processing methods can affect the phytochemical composition of food substances which is in line with the report of Parada and Aguilera (2007).

Results of the proximate composition of the samples (Table 2) indicates that boiled beetroot samples had the highest moisture content of which is followed by rawand then roasted beetroot. The high moisture content of beetroot correlates with the work of Guldiken *et al.* (2016). The crude protein content of a food sample represents the total nitrogen (N) in the diet which includes not only true protein but also non-protein nitrogen (e.g., urea and ammonia in a feed but nitrate is not included). The crude protein content was found higher in raw beetroot while boiled beetroot had the lowest protein contents. The decrease in protein content as observed in the crude protein is likely to be an indication that some proteins were lost or denatured during processing. The result agrees with the work of Omotosho *et al.* (2015).

Crude fat is an estimate of the total fat content of foods. Crude fat contains (triglycerides) as well as alcohols, waxes, terpenes, steroids, pigments, ester, aldehydes, and other lipids.The highest crude fat content was found in roasted beetroot, while the lowest crude fat content was found in boiled beetroot (Table 2). The result is an indication that roasted beetroot kept the fat content intact and freed up when compared to the raw sample. The decrease in crude fat in boiled beetroot is an indication that fat may have been lost in the water used in cooking the beetroot.

Ash is the inorganic residue remaining after the water and organic matters have been detached, which provides a measure of the total amount of minerals within a food (Lewu *et al*., 2009). The highest ash content was found in roasted beetroot followed by raw beetroot and then boiled beetroot Table 2. The high ash content found in the roasted sample is a reflection that food processing by roasting can reduce the loss of important minerals as opposed to boiling processing method.

Dietary fiber consists of non-starch polysaccharides and other plant components,they can act by changing the nature of the contents of the gastrointestinal tract and by changing how other nutrients and chemicals are absorbed (Eastwood and Kritchevsky, 2005).When crude fibre content is higher, the energy content of the feed is lower because crude fiber is considered as indigestible. Crude fibre content was found in the increasing order ofroasted, raw, and boiled beetroot. The highest carbohydrate content was found in roasted beetroot while raw beetroot had the least carbohydrate content (Table 2).

Minerals serve as cofactors of important enzymes in the body. The deficiency of some of them could be deleterious to health. The trace mineral compositions analysis of this study revealed varying concentrations of the minerals (Table 3). Roasted beetroot sample had the highest Fe content, while the least Fe content was found in boiled beetroot. Boiled beetroot had the highest Zn content, while raw beetroot had the lowest Zn content.Copper(Cu) content was found higher in roasted beetroot whereas the least Cu content was found in raw beetroot sample and boiled beetroot which is not significant in mean. The highest levels of Mn were found in raw beetroot, while the lowest was found in boiled beetroot. The highest Se content was found in roasted beetroot compared to the raw and boiled beetroot. The sum mean concentration of the analysed trace mineral were found in the following order: Roasted (2.72) > Boiled (2.06) > Raw (1.86). From the foregoing, it can be inferred that heat application to beetroot may result to changes in its phytochemicals and nutritional values. Comparing the three processing methods, roasting beetroot before consumption is recommended.

CONCLUSION

Processing makes food healthier, safer, and more delicious and has a stronger shelf. While the benefits are many, processing can also be harmful, affecting the nutritional quality of foods. The results obtained from thisstudy shows that beetroot is a good source of nutrient such as carbohydrates, proteins, fibre, phytochemicals, and minerals. The nutrients found in raw, roasted, and boiled beetroot were found to be different. This is an indication that processing methods could lead to changes in biochemical compositions of food and affect their nutritional qualities.

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