Effects of Maturity on the Proximate Composition of Lettuce (*Lactuca sativa*)

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ABSTRACT

The effects of maturity on some proximate compositions of lettuce are reported in this study. Samples of lettuce (Lactuca sativa) were collected from a lettuce grower at "Chanchaga" in Minna, Niger State, Nigeria 50, 60 and 70 days after transplanting (DAT). For each of the stages of maturity the samples were analysed for carbohydrate, fat, protein, fibre, ash, moisture, vitamin C and beta carotene contents using techniques adopted from various standard methods. All analyses were done in triplicates. A one- way ANOVA was used to analyse the data obtained. The average value of carbohydrate (11.44±0.66%) obtained from the samples harvested 50 DAT was significantly higher ($p\leq 0.05$) than those harvested 60 and 70 DAT. The average values of all the assessed proximate compositions of the lettuce harvested at the three different maturity stages showed significant variations ($p\leq 0.05$) but the trends in these variations differed from one parameter to the other. The protein and fat contents of the assessed samples showed a clear increase in values as the harvest days after transplanting increased, the other parameters do not have a clear pattern variation among the three different maturity stages investigated. It is then concluded from this study that proximate composition of lettuce is actually influenced by the stage of maturity at harvest. However, the variations have no definite pattern, while in some parameters the values increased with increase in stage of maturity, others do not have definite pattern in the changes

Keywords: Lettuce, maturity, date after transplanting, dry matter, vitamin C, beta carotene

INTRODUCTION

Lettuce (*Lactuca sativa*) is a temperate annual or biennial plant of the *Daisy* family, *Asteraceae*. Today, world lettuce production is put at more than 22 million tonnes on about 1 million hectares (Mou, 2008). About two-thirds of the total production area is in Asia, with China alone accounting for about half of the world's total production. Though the quantity of lettuce produced annually in Nigeria is not readily available in literature, the consumption of lettuce has become popular in most urban centres in Nigeria. Leafy vegetables are important items of diet in many Nigerian homes. Apart from the variety which they add to the menu, they are valuable sources of nutrients especially in rural areas where they contribute substantially to protein, mineral, vitamins, fibre and other nutrients which are usually in short supply in daily diets (Mosha and Gaga, 1999). Besides, they add flavour, taste, colour and aesthetic appeal to what would otherwise be a monotonous diet.

There are five major types of lettuce: crisphead (iceberg), romaine, leaf, butterhead, and stem. The nutritional value of lettuce varies greatly with type (Hart and Scott, 1995; Mou, 2009). Lettuce is mild in flavour and serves as supplement to other ingredients in a salad (Solomon, 2000). It is a dietary source of vitamin A (relatively high in beta-carotene content), vitamin K, vitamin C, folate and manganese. Lettuce contains minerals, vitamins, proteins, starch, non-starch polysaccharide (polymers) and natural antioxidants (e.g., vitamins C and E; and ß-carotene). These components may help in the reduction of chronic diseases such as atherosclerosis, coronary heart diseases, diabetes, large intestine cancer, cardiovascular disease, eye defects and anaemia (Cordenunsi *et al*., 2008; Patthamakanokporn *et al*., 2008; Arvanitoyannis and Mavromatis, 2009). It is clear from the above analysis that lettuce is an important vegetable that provides Vitamin C and β-carotene.

One major problem that farmers face is the appropriate time or stage of maturity to harvest their fresh fruits and vegetables. This is also compounded by postharvest handling of these products to minimise losses. Maturity is the stage of development of fruits and vegetables that influences the consumption for a specific function depending on the commodity (Watada *et al*., 1984).

In most instances, the head lettuce is ready for harvesting in 70 to 80 days after seeding or 60 to 70 days after transplanting. Normally only those heads that are firm are cut. Three to four "wrapper" leaves are left to protect the head. Most leaf types are ready in 50 to 60 days after seeding and 30 to 45 days after transplanting. Lettuce is harvested every 2 to 3 days, depending on moisture and temperature (Tan, 2005). Proper maturity is important because of yield, shelf life and eating quality. Immature heads will be soft and lightweight, and shelf life will be reduced. Over-mature heads will be very compact with a tendency to split. Over-maturity usually is accompanied by elongation of the core and reduction in shelf life.

It is therefore desirable to investigate how the stage of maturity affects the nutritional parameters of lettuce so as to obtain the optimum period or stage of maturity that will give the best results in terms of nutrient retention. The stage at which the product is harvested also influences the postharvest quality of the product.

MATERIALS AND METHODS

Sourcing and Preparation of Samples

Samples of lettuce (*Lactuca sativa*) were collected from a lettuce garden in Chanchaga in Minna, Niger State, after 50, 60 and 70 days of transplanting. Edible portions (100 g) of the vegetable was cut into small pieces and homogenised using a blender. The homogenised sample was transferred into an air-tight container ready for vitamin analysis. For each of the stages of maturity, the samples were analysed immediately after harvest for the proximate compositions. All procedures were carried out carefully without much exposure to light. All the chemicals and reagents used were of analytical grades. All analyses were in triplicates.

Determination of Dry Matter Content of Lettuce

Dry matter was determined according to the method described in AOAC (2005) nutritional guidelines. The following components of dry matter were determined: carbohydrate, protein, crude fibre, total lipid (fat) and ash.

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Determination of Ascorbic Acid Content of Lettuce

Extraction of vitamins

Vitamin C

Vitamin C was extracted according to the modified method of Abdulnabi *et al*. (1997). The sample (10 g) was homogenised with an extracting solution containing meta-phosphoric acid (0.3 M) and acetic acid (1.4 M). The mixture was placed in a conical flask (wrapped with aluminium foil) and agitated at 100 rpm with the aid of an orbital shaker for 15 min at room temperature. The mixture was then filtered through a Whatman No. 4 filter paper to obtain a clear extract. The ratio of the sample to extraction solution was 1 to 1. All samples were extracted in triplicates.

Determination of β-Carotene Content of Lettuce

The *β*-carotene in the sample was extracted according to the method described by Tee *et al*. (1996).

Data are expressed as mean value ± standard deviation. Independent t-test was applied to determine the significant differences at the level of $p<0.05$. A Statistical Package for Social Science (SPSS) for Windows version 15.0 was used to analyse the data.

RESULTS AND DISCUSSIONS

The average values of the proximate compositions of lettuce harvested at different maturity stages are shown in Table 1.

Carbohydrate Content

The average values of the carbohydrate contents of the samples harvested 50 days after transplanting was significantly higher ($p\leq 0.05$) than those harvested 60 and 70days after transplanting. The minimum carbohydrate content (6.04±0.22%) was recorded in the lettuce samples harvested 60 days after transplanting. The average values of carbohydrate obtained in this study differed slightly from the range of values given for different types of lettuce by Mou, (2009). The variation may be attributed to varietal differences as well as other environmental conditions.

Table 1. Average Proximate Composition of Lettuce harvested at different Stages of Maturity

Parameter	*50 DAT*	*60 DAT*	*70 DAT*
Carbohydrate (%)	11.44^{a}±0.66	6.04^{c}±0.22	7.43^{b}±0.24
Fat (%)	3.04^{c}±0.10	3.85^{b}±0.09	4.45^{a}±0.08
Protein (%)	14.22^{c}±0.08	16.31^{b}±0.2	19.98^{a}±0.12
Fibre (%)	1.94^{a}±0.28	1.87^{a}±0.06	1.25^{b}±0.10
Ash (%)	0.37^{b}±0.09	0.98^{a}±0.06	0.93^{a}±0.04
Moisture (%)	69.63^{b}±0.56	70.72^{a}±0.28	65.99^{c}±0.16
Vitamin C (mg/g)	2.28^{a}±0.05	2.01^{b}±0.10	2.19^{a}±0.02
β-carotene (abs/ml)	19.10^{a}±0.33	16.34^{c}±0.14	17.34^{b}±0.15

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Values on the same row with different superscripts are significantly different from each other ($P \leq 0.05$) while those with the same letters are not significantly different from each other. DAT means days after transplanting.

Fat

The results (Table 1) show that the fat contents of the lettuce samples increased with the days of maturity. Significant variation in the fat content was observed in the samples of lettuce harvested at the three different days of maturity after transplanting ($p \leq 0.05$). The fat contents of the lettuce head harvested 50 days after transplanting was significantly lower than the values of those harvested 60 and 70 days after transplanting. It has been observed that the process of maturation and ripening results in changes in fruit and vegetable physicochemical properties such as volatile components (Dadzie and Orchard, 1997). The average values of fat content obtained in this study were generally higher than those given in literature (Mou, 2009). The differences could be due to factors such as varieties and environment in which the produce was cultivated.

Protein

The results (Table 1) obtained for the protein contents of the lettuce samples harvested at different maturity stages also showed some significant variation ($P \leq 0.05$). The highest average value of protein (19.98±0.12%) was obtained in samples of lettuce head harvested 70 days after transplanting and was significantly different from the values obtained from the samples harvested 50 and 60 days after transplanting. It seems that the accumulation of some of these nutrient levels increase with maturity stage. The results obtained in this study are in agreement with those of Onyango *et al.* (2012), who stated that the total phenolics and quercetin levels increase with maturity of the vegetables.

Fibre

The results (Table 1) of the crude fibre show that there were no significant differences ($p \leq 0.05$) in the average values of fibre contents obtained from the samples of the lettuce head harvested 50 and 60 days after transplanting. These values, however, differed significantly ($p \leq 0.05$) from the average values obtained from the samples harvested 70 days after transplanting which was significantly lower in values. The average values of fibre content obtained in this study compared favourably with the values given in literature (Mou, 2009) which gave a range of 0.9 – 2.1g/100g fresh weight of samples for five different varieties of lettuce.

Ash content

The average value of ash content obtained (Table1) from the samples of lettuce head harvested 50 days after transplanting was significantly lower ($p \leq 0.05$) than the average values obtained from those harvested 60 and 70 days after transplanting. The highest value (0.98±0.06 %) of ash content was observed in the samples harvested 60 days after transplanting.

Moisture Content

The average moisture contents of the samples harvested 60 days after transplanting (DAT) were significantly higher ($p \leq 0.05$) than those of samples harvested 50 and 70 days after transplanting. Generally the average moisture content obtained for samples of lettuce

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harvested at different stages of maturity were lower than those given (80-95 %) in literature (Mou, 2009). These differences could be attributed to differences in varieties and other environmental factors. It has been noted that the amount of moisture in the vegetables affects the nutrient concentration in the vegetables. For instance, Mou (2009) stated that the carotenoid levels of wild lettuces were higher than the cultivated lettuces. These differences were attributed to the fact that wild lettuces had much lower water content.

Vitamin C

The average values of vitamin C content (Table 1) show that the samples harvested 50 days after transplanting have the highest value while those harvested 60 days after transplanting have the lowest value. The results showed that the average values of vitamin C of the samples harvested 50 and 70 days after transplanting were not significantly different ($p \leq 0.05$) but these values differed significantly from the values for those harvested 60 days after transplanting. In general, the average values of vitamin C obtained in this study fell within the values given in literature (Mou, 2009) for different types of lettuce.

Beta- Carotene

The results (Table 1) show that the average values of beta-carotene obtained from the samples of lettuce head harvested at different maturity stages varied significantly ($p \leq 0.05$). The samples harvested 50 days after transplanting gave the highest value (19.10±0.33 abs/ml) while those harvested 60 days after transplanting gave the lowest. It has been reported that there is usually a drop in the content of beta carotene in fruits and vegetables during ripening (Ahamad *et al.*, 2007).

Maturity is one of the major factors that determine the compositional quality of fruits and vegetables (Lee and Kader, 2000; Kader, 1988). Studies have shown that ascorbic acid content (vitamin C) increased with ripening on the plant in apricots, peaches and papayas, but decreased in apples and mangoes. It is observed from this study that the vitamin C content obtained did not give any definite pattern as regards the stage of maturity of the lettuce because the values obtained in samples harvested 50 DAT were the highest while those for samples harvested 60 DAT were the lowest. These results are however, in agreement with observation that large and more matured peas contained less ascorbic acid than smaller and immature peas (Lee *et al*., 1982). Nagy (1980) reported that immature citrus fruits contained the highest concentration of vitamin C, whereas, ripe fruits contained the least. It was noted that although vitamin C concentration decreased with maturation of citrus fruits, the total vitamin C content per fruit tended to increase because the total volume of the juice and fruit size increased with maturity. Similar effects of stage of maturity of fruits and vegetables on other proximate compositions have been reported by other authors. Kader, (1988) revealed that both ascorbic acid and total carotenoids (beta carotene or previtamin A is predominant) increased with maturation and ripening in Clingstone Peaches. It is also revealed that content of vitamin C varies with plant species and different environmental factors (Puia *et al*., 2009). For instance, it was observed that the concentration of vitamin C in plants increases with maturity. Golcz and Kozik, (2004) revealed that irrespective of the applied type of nitrogen fertilizer, pepper fruits harvested in the phase of full fruiting contained 30 % more vitamin C in comparison to the fruits harvested in the phase of physiological maturity. The green fruits (irrespective of cultivars) of sweet pepper contained less vitamin C than the red of yellow fruits. It can be noted from these observations from other studies that the variation in the

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vitamin C contents in fruits and vegetables with stages of maturity differed for different fruits and vegetables. While some showed increase in the values as the maturity or ripening stages increased, others showed decrease in values with increase in maturity.

Ahamad *et al*. (2007) quoted Rigo *et al*. (1999) that content of beta carotene drops by 77% during ripening process. The results obtained for the beta carotene in this study is in agreement with this findings as the values for the samples harvested at 50 DAT was significantly higher than those from the samples harvested 60 and 70 DAT.

Though, it is revealed that lettuce can be harvested almost any time during growth. Studies have shown that, Crisphead lettuce should be harvested when crops are in the early heading stage and that Leaf lettuce may be picked any time after leaves form, but before the seed stalk forms (Drost, 2010). Garrison (2005) gave 70 – 90 days from planting to maturity under optimum growing conditions as approximate days to harvesting for lettuce head and 40-50 days for lettuce leaf. In situations where certain specifications are given by processors of lettuce, growers must focus on both the yield and processing quality of crop at the point of harvest as choosing the best time to harvest lettuce involves a balance between yield and quality. It has been noted that head weight and total yield can be increased with no loss in quality by harvesting lettuce at the correct maturity stage (Titley *et al*., 2007). The studies revealed that the core length of Cos lettuce increased with later harvest dates. For instance, a core length of 90 mm was obtained from lettuce harvested 69 days after transplanting (DAT) and this was above processing specification, while an average core length of 65 mm obtained for those harvested 61 days after transplanting (DAT) was acceptable to processors. So it was the sample harvested 61 DAT which have generated the maximum yield within specified quality for fresh cut lettuce (Titley *et al*., 2007). It is however, observed that these parameters are dependent on environment, varieties and time conditions among other factors that influence such parameters.

It has thus been noted that in order to obtain a high quality lettuce product that satisfies consumers' demand regarding both nutritional and organoleptic quality, one must choose an optimal maturity stage at harvest because lettuce maturity stage selection is one of the preharvest factors determining the quality of the final product (Chiesa *et al*., 2003). If vegetables are not harvested at the proper stage of maturity, physiological processes occur that permanently change their taste, appearance and quality. The texture, fiber and consistency of all vegetables are greatly affected by the stage of maturity at harvest, post-harvest handling and by the time interval between harvesting and consumption (Westerfield, 2011). Harvesting most vegetables when they are young and storing them properly will help extend their shelf life. While it is observed that harvesting too soon may result in only a reduction in yield, harvesting too late can result in poor quality due to development of objectionable fibre and conversion of sugars into starches. In the case of lettuce, it is revealed that harvesting too early, the head may not fully be formed. The optimum maturity is when it is fairly firm and good size, while too late may result in the head being very hard.

CONCLUSIONS

The analyses conducted in this study on the stage of maturity on the proximate composition of lettuce though, did not give results which would allow for drawing general conclusions concerning the direction of changes in these nutrients under the influence of stage of maturity, the basic information provided are bases for further research work. While some of the nutrients (fat and protein) clearly showed definite increase in values as the days after transplanting increased, others did not have definite pattern. Such behaviour as noted here are not far from observations made by other researchers concerning the influence of environment, varieties, experimental conditions and time as they affect the nutritional composition of fruits and vegetables. It can be concluded from this study that proximate composition of lettuce is actually influenced by the stage of maturity at harvest. However, the variations have no definite pattern, while in some parameters the values increased with increase in stage of maturity, others do not have definite pattern in their changes.

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