Effect of Soaking Water Temperature and Time on some Rehydration Characteristics and Nutrient Loss in Dried Bell Pepper

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ABSTRACT

Sun-dried bell pepper was rehydrated at soaking water temperatures of 31°, 37°, 55°, 72° and 90°C, respectively. As the soaking water temperature increased from 31 to 72°C, rehydration ratio and coefficient of rehydration increased from 4.26 to 5.93 and 64.56 to 93.49 respectively while a further increase in soaking temperature to 90⁰C, resulted in a decrease from 5.93 to 4.57 and from 93.49 to 75.77 respectively for the two parameters. At higher soaking water temperatures, larger amounts of vitamin C leached into the soaking water. However for Ca and Fe larger amounts were leached into the soaking water at lower soaking temperatures.
Keywords: Rehydration, mineral content, vitamin content, Nigeria

1. INTRODUCTION

The nutritional value of fruits and vegetables as sources of minerals, vitamins, dietary fibre, protein and energy as documented by Salunkhe *et al.* (1991) has made them an indispensable part of the human diet. The nutrients (especially vitamin and mineral contents) which can be obtained relatively cheaply from bell pepper are very important for human body maintenance. The nutritional composition of the red bell pepper as reported by Ngoddy and Ihekoronye (1985) is shown in Table 1 below.

Table 1. Nutritional composition of red bell pepper

Nutrient	Composition
Mositure	7.4%
Protein	4.1%
Fat	2.3%
Calcium (per 100g)	58 mg
Iron (per 100g)	2.9 mg
Riboflavin (per 100g)	0.20 mg
Niacin (per 100g)	2.4 mg
Ascorbic acid (per 100g)	121.0 mg

Source: Ngoddy and Ihekoronye (1985)

However, these fruits and vegetable crops such as tomatoes, okra and pepper, are highly perishable which deteriorate within a few days of harvest if not processed because of their high moisture content. It has been observed that post harvest losses of these vegetables can be as high as 30% (Tunde-Akintunde and Akintunde, 1996). They are also seasonal crops, although they are usually demanded all year round demand. Thus, the commodities have to be preserved so as to be available during off-season. Sun drying is a common traditional method of preserving fruits and vegetables. It helps to conserve perishable crops and extend their shelf-life beyond the few weeks when they are in season (Kordylas, 1991). Sun drying helps to preserve bell-pepper (*Capsicum annuum*) better because it helps to concentrate the protein. However, some nutrients are unavoidably destroyed (Roiz, 1997).

Dried fruits and vegetables may be rehydrated or reconstituted (to restore lost moisture) by soaking the food in water. Most dried vegetables take two hours to rehydrate or reconstitute. Rehydrated/reconstituted fruits and vegetables should be cooked in the water in which they were soaked because of nutrient leaching (Roberts and Cox, 1999). Sun-dried pepper is usually rehydrated or reconstituted through soaking in water for some time before mixing and grinding with other vegetables to make stews. The main advantage of soaking the dried bell pepper is to reconstitute the pepper and make it tender thus resulting in more efficient grinding of the pepper along with other ingredients. However, during soaking of the dried food materials in water, leaching of nutrients and colour pigments occur which results in further reduction of the nutrients of the pepper available to the consumer.

This study was carried out to study the effect of soaking water at different temperatures on some rehydration characteristics of bell pepper and to examine the extent of leaching of minerals and vitamins during soaking.

2. MATERIALS AND METHODS

Bell pepper (*Capiscum annuum*) of uniform sizes of 1.58 mm diameter, 2.74 mm height and 2.76 mm thickness was purchased from a market in Ibadan and dried by placing directly in the sun and dried until there was no change in weight of the dried samples after three consecutive weighing. The moisture content of the dried samples was determined according to AOAC (1990) and it was 20.21% dry basis. The water absorption of the pepper was determined by placing a sample of 200g in a basket and immersing into a beaker containing 500 ml of distilled water heating to the required soaking temperature. The soaking of the pepper was carried out at temperatures of 31^{o}C (room temperature during the time the experiment was being carried out), 37^o, 55^o, 72^o, 90^{o}C respectively. Beakers were placed in a water bath (Equitron, Mumbai 400013, India), which was controlled at the required temperature. Throughout soaking, the samples were immersed in water and taken out of the water bath after 30 minutes of soaking. The water was drained and surface moisture was wiped with the help of filter cloth before it was weighed as described by Shittu et al. (2004). The procedure was repeated at intervals of 30 minutes for 5hours. Each of the determination was carried out in duplicate.

The soaking water was analysed to determine the colour, vitamin and mineral content that had leached into it using the AOAC Standard (AOAC, 1990). The colour of the soaking water was determined using a colorimeter **(**CIBA, Corning 252, England**)** to determine the transmittance at 470nm of the water.

The vitamin C content was determined by the method of AOAC (1990) as follows: weighing 5g of sample were weighed into a volumetric flask and adding 10 ml of extracting solution. 10 ml of the solution was pipetted into a small flask and titrated with 2,6 dichlorophenol solution. The vitamin C content was then calculated from the titre value. The mineral content was determined by the method of AOAC (1990) as follows: a quantity of 0.5g of dried ground samples was weighed into a 75 ml digestion tube; 5 ml of the digestion mixture was added and placed in a fume hood. It was digested for 2 hrs at 150^oC, and then cooled for 10 minutes. 3 ml of 6N HCL was added and mixture digested for another $1^1/_2$ hours before it was cooled. 30 ml of distilled water was added and mixture stirred. After cooling the volume was made up to 75 ml mark and the tube shaken. The mixture was then transferred to auto analyses cups for total mineral analysis according to AOAC (1990).

The rehydration parameters were determined according to USDA (1944) and Van Arsdel *et al.* (1973) as rehydration ratio and coefficient of rehydration as shown in equations (1) and (2):

$$\text{Rehydration ratio (RR)} = \frac{W_R}{WD} \quad \text{.............. (1)}$$

$$\text{Coefficient of rehydration (CR)} = \frac{W_R}{W_o} \quad \text{............. (2)}$$

Where W_R = drained weight of rehydrated sample
W_D = weight of dehydrated sample
W_o = weight of sample before dehydration

3. RESULTS AND DISCUSSION

The rehydration of the sun-dried bell pepper is shown in Fig 1. It was observed that the moisture content of the pepper increased with increase in temperature and time of soaking. However, the amount of water absorbed per unit time increased with increase in soaking temperature. The initial moisture content (dry basis) was 20.21% while the highest final moisture content attained after 5 hours of soaking was 584.36%.

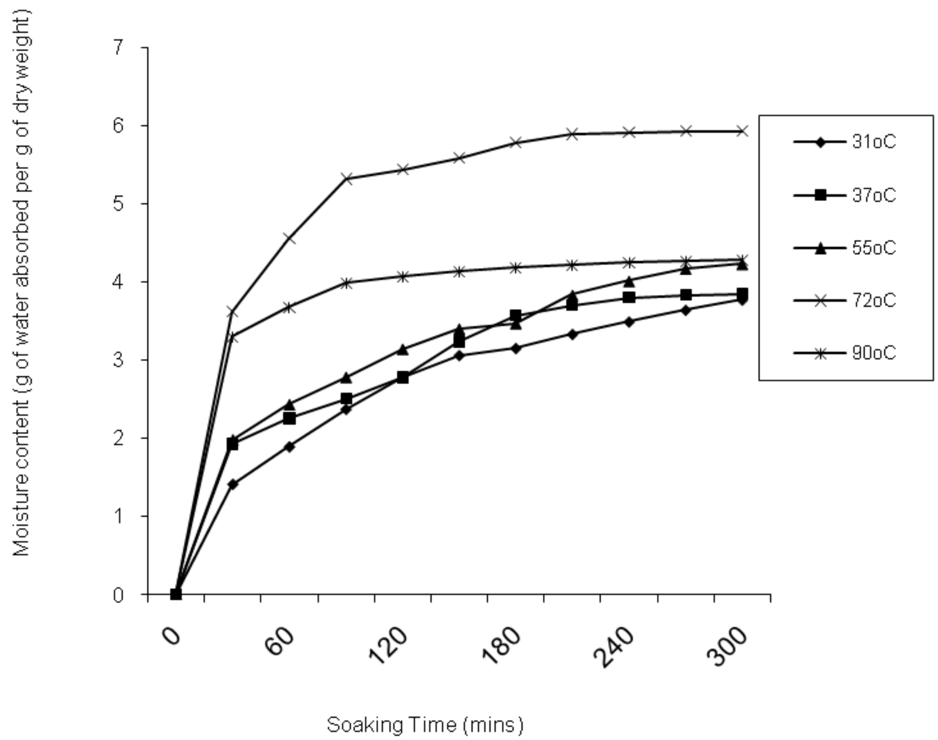

Fig 1. Rehydration of sun-dried bell pepper

From Fig 1, the moisture absorption rate for the dried bell pepper was highest within the first 120 minutes during which about 90% of total moisture absorption took place. Additional increases were recorded up to 300 minutes of soaking. These curves exhibit characteristic moisture absorption patterns where initial high rate of water absorption is followed by slower absorption in later stages (Ituen *et al*., 1985). This slower absorption may eventually be such that the increase in reconstitution ability becomes very small at higher soaking times. Gowda and Gupta (1988) observed that an increase in soaking onions beyond 20 minutes gave very small increase in reconstitution ability.

Soaking of sun-dried food products for half to two hours have been identified as giving an acceptable result while continuous soaking for up to six hours produced a more tender product (Roiz, 1997).

It can be observed from Fig 1 that as the temperature of the soaking water increased, rehydration became faster and higher moisture contents were reached within the same time interval. This is probably due to the fact that increase in the temperature of the soaking water resulted in the rapid absorption of water as a result of a more open structure which favoured rapid rehydration. This is similar to the observation of Brennan et al., (1990) that reconstitutability of food products depend principally on the internal structure of the dried pieces, extent to which water-holding components (e.g. protein and starch) have been damaged during drying. They also indicate that the rate at which air-dried vegetables reconstitute is increased when the food has an open, porous structure.

At the highest soaking temperature of 90^oC however, the increase in moisture content was lower than that at 72^oC. This may probably be due to the fact that the high soaking water temperature resulted in shrinkage and/or loss of elastic properties of cell tissues rather than causing an opening up of the pores, which invariably reduced the rate of rehydration. This is in agreement with data shown in Table 2 where the rehydration ratio and coefficient of rehydration both increased with increase in temperature of soaking water but a further increase from 72 to 90^oC resulted in a decrease in the rehydration parameters. This indicates that increasing the soaking water temperature to 90^oC or above should be avoided since it will result in reduced moisture content of rehydrated samples.

Table 2. Rehydration parameters of bell pepper soaked for 300 minutes

Temperature of Soaking (^oC)	Rehydration Ratio	Coeff. of Rehydration
31	4.36	64.56
37	4.38	68.29
55	4.40	69.17
72	5.93	93.49
90	4.57	75.77

The vitamin and mineral contents of the dried sample and the rehydrated samples are indicated in Table 3 while the vitamins and minerals leached from sun-dried pepper into the soaking water is shown in Table 4. The residual amount of Iron (Fe) and Calcium (Ca) in the rehydrated samples increased with an increase in soaking water temperature. This corresponds to the result of Table 4 in which larger amounts of Fe and Ca were leached into the soaking water at room temperature, and this reduced as the soaking water temperature increased. This indicates that losses of the minerals from the rehydrated bell pepper can be reduced by using soaking water at lower temperatures for rehydration. This is to avoid deficiency in any of the nutrients since such will make the body cells to malfunction (Tull, 1996).

Table 3. Vitamin and mineral content in dried and rehydrated bell pepper

	Temperature of Soaking (^oC)	Vitamin C (mg/100g)	Ca (mg/100g)	Fe (mg/100g)
Dried bell pepper		56.33	6.02	0.58
Rehydrated samples	31	39.06	0.11	0.08
	37	35.06	0.18	0.10
	55	23.11	0.21	0.15
	72	10.06	0.35	0.22
	90	0.18	0.52	0.43

Table 4. Vitamin and mineral content leached into soaking water

Temperature of Soaking (^0C)	Vitamin C (mg/100g)	Ca (mg/100g)	Fe (mg/100g)	Colour of Soaking Water (% Transmittance at 470nm)
31	15.5	0.0281	0.0035	13.5
37	19.5	0.0198	0.0014	30
55	30.7	0.0177	0.0015	43
72	41.2	0.0165	0.0012	43.5
90	52.3	0.0066	0.0016	56

From Table 4, the amount of vitamin C leached into the soaking water increased with increase in soaking temperature. This may be due to the fact that vitamin C is water-soluble and thus dissolves in water and also because vitamin C is destroyed by heat (Tull, 1996). The body requirement of Vitamin C must be supplied by food because of the inability of the human body to make most of the vitamin by itself. Vitamins are needed to regulate the maintenance and growth of the body and to control metabolic reactions in cells and thus high leaching of these from food sources before consumption is not desirable.

These minerals and vitamins are important because they are required for the proper functioning of body cells, muscles and nerves (Tull, 1996) and therefore processing of fruits and vegetables should result in as little loss of these nutrients as possible. However, since the loss of some of the nutrients occurred with soaking water at room temperature and loss of others occurred with the use of soaking water at high temperatures, this implies that soaking has to be optimsed in order to have rehydrated samples of good quality. However, from Fig 1, the moisture gain of the bell pepper after 5 hours of soaking at room temperature of water is slightly higher than the moisture gain of the bell pepper after one hour of soaking at a high temperature of 90^oC. This will likely give lower amounts of leached nutrients because of the reduction in the soaking time. Therefore, bell peppers may be soaked at room temperature for about 5 hours and at higher soaking temperatures for a short duration in order to retain its nutritional quality.

4. CONCLUSION

Although the rehydration ratio was highest at high soaking water temperatures, the amount of nutrient leached into the soaking water was also higher at these temperatures, thus soaking at higher temperatures will result in the reduction of food quality even though it gives rehydrated/reconstituted bell pepper of higher moisture content. Soaking at higher temperatures for shorter soaking times may also be considered for rehydration/reconstitution of sun-dried bell pepper.

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