International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 8, August 2015.
www.ijiset.com
ISSN 2348 – 7968

Effects of Brine Preservation on the Shelf Life of Lettuce (*Lactuca Sativa* L.) stored under Tropical Ambient Temperature

Evans A. Alenyorege[1], Thomas A. Adongo[2] and Hussein Y. Alhassan[3]

[1, 2] Department of Agricultural Mechanization and Irrigation Technology, University for Development Studies, Tamale, +233, Ghana

[3] Department of Agricultural Engineering, Tamale Polytechnic, Tamale, +233, Ghana

Abstract

The Preservative effect of brine at different concentrations on lettuce at tropical ambient temperature was examined. The effect of various concentrations of salt solutions on leaf surface and edge browning, texture, and colour were observed for five days. The experiment was laid out in a Complete Randomized Design (CRD) and each treatment repeated in triplicates including a control. Sensory qualities were examined by six panelists using a 5-point hedonic scale ranking. Results indicated that at brine concentration of 20% and 25%, quality parameters observed remained acceptably intact for the entire duration of preservation. The strong brines of concentration by weight 20% and 25% were effective in reducing browning and maintaining texture and colour followed in succession by control (0%) >15% > 10% > 5%. Lettuce preserved under this method may be covered with equal volume of water, cooked and served, used in soups or in a mixed vegetable dishes. This method can be used in preserving large quantities of fresh lettuce and other vegetables when handling facilities are limited.

Keywords: Lettuce, brine, concentration, hedonic, shelf life

1. Introduction

In Ghana, *Lactuca sativa* L. (Asteraceae) is considered the most important vegetable in the group of leafy vegetables. It is composed of soft leaves that contain more than 95% water, and is used in fresh foods and salads because of its ability to improve the appearance of food and increase the nutritional composition of prepared salads (King *et al*., 1991).

Lettuce is almost exclusively used as a fresh vegetable in salads, but some forms are also cooked in other kinds of food, such as soups, sandwiches and wraps (Lebeda *et al*. 2007). It is considered one of the most popular of minimally processed vegetables, and a growing demand for this convenient to use and time-saving vegetable has occurred in developed countries over the last few years (Ragaert *et al*., 2004). This vegetable is very popular due to its crispy texture, attractive green leaves, neutral taste and green aroma (Rico *et al*., 2007). Lettuce is cultivated as a commercial vegetable in many countries worldwide and is also largely grown as a vegetable in homes or backyard gardens (Rubatzky and Yamaguchi, 1997).

Lettuce and other vegetables are highly perishable products mostly after harvest. As they are metabolically active, they tend to lose stored energy through respiration and water through transpiration (Sapers, 2003). In addition to the biochemical changes, there may be losses in quality through mechanical injuries, pests and diseases, as well as physiological disorders induced by high or low temperatures or unsuitable storage atmosphere (Sapers, 2003).

Vegetables like lettuce provide an inexpensive source of energy, body-building nutrients, vitamins and minerals.The nutrient content of lettuce is important because of the large quantities consumed. It includes several important constituents such as phenolic antioxidants as caffeic acid derivatives (Tomas-Barberan *et al*., 1997) and flavonoids , vitamins A and C, calcium, and iron (USDA Nutrient Data Laboratory, 2004). Despite its beneficial qualities, lettuce when handled unhygienically, is often a source of bacterial, viral and parasitic epidemics in humans, including *E.coli and Salmonella* (Khadre *et al*, 2001). As with most vegetables, lettuce is marketed throughout Ghana in fresh produce markets and some stores.

Their nutritional value is highest when they are fresh, but it is not always possible to consume them immediately. During the harvest season, fresh produce is available in abundance, but at other times it is in short supply. Most vegetables including lettuce are only edible for a very short time, unless they are quickly and suitably preserved. Over the years, consumer demand has increasingly required vegetables to have more natural flavour, texture and colour, with a shelf life that is sufficient for

ISSN 2348 – 7968

distribution and a reasonable period of home storage before consumption. This can be achieved by postharvest pretreatment methods that preserve vegetables but also retain to a greater extent their nutritional quality and sensory uniqueness.

Brining or salting is the oldest and cheapest way of preserving vegetables, meat, fish and other foods whilst maintaining a fair amount of their nutritional value (Fraser, 2005). Salt absorbs much of the water in the vegetables and makes it difficult for microorganisms to survive. In brine preservation of vegetables, the preserving effect is obtained by the combined action of the salt and the acid produced by fermentation.

Four different ways of salting or brining vegetables has been identified by Fraser (2005): They comprise i) weak brine (5-15% by weight); ii) strong brine (15-25% by weight); iii) a weak brine (5-15% by weight) plus vinegar and iv) a strong brine (15-25% by weight) plus vinegar.

The study employs the first two forms of brining to test the effect of brine of different concentrations on the shelf life of lettuce stored under ambient conditions.

2. **Methodology**

2.1 Source of Plant Material

Fresh Lettuce (*Lactuca sativa* L.) were purchased at farm gate immediately after harvest at Gumbihini a popular dry season vegetable growing area in Tamale in the Northern region of Ghana. It was transported well protected against any form of damage to the experimental site.

2.2 Preparation of Treatments

The various solutions were prepared on weight per unit weight basis (w/w). They were expressed in grams of solute (salt) per 100 grams of solvent (water) and presented as a percentage. The solutions of concentration 5%, 10%, 15%, 20% and 25% were each prepared using 5g, 10g, 15g, 20g and 25g of salt per 100g of water respectively using the following equation:

$$\% \quad \text{concentration} = \frac{S}{100\text{ g of Water}} \times 100\%$$

Where, S = weight of solute (g)

2.2 Preparation of Samples for Storage

Green firm lettuce leaves were sorted from a mixture of leaves and washed under running tap water to remove any remaining dirt. The leaves were placed gently on a stainless steel drain for water to drain off . Lettuce leafs (20g) were immersed in each solution for 3 minutes, drained and stored in open plastic bowls at a temperature of 26-30°C.

2.3 Experimental Design

The treatments were arranged in a completely ramdomized design (CRD) using the principle of random numbers and each replicated thrice. Due to the perishable nature of lettuce, the experiment was evaluated every 24 hours (daily) for five (5) days.

2.4 Sensory Methodology

According to Stone and Sidle (2004), sensory evaluation is a scientific testing method for precise measurement of human responses as perceived by the five senses. Sensory evaluation is a vital part of food development because it is the essential means of determining how consumers will respond to a food or food material. Reliable sensory evaluation can be performed by optimizing four steps: definition of the problem, test design, instrumentation, and interpretation. People evaluate a particular food primarily based on how it looks smells, tastes, sounds, and feels. The food attributes that are typically perceived through the human senses are appearance, smell, taste, flavor, consistency and texture.

2.5 Description of Method

Sensory evaluation was carried out using a 5-point hedonic scale ranking (Peryam and Girardot, 1952). Leaf browning, texture and colour were evaluated daily under broad day light by a six member panel of three men and three women who, on several occasions prepared and consumed lettuce. Browning (leaf edge and surface) was scored on a 5-1 scale, where 5= no browning, 3 = moderate browning, and 1 = severe browning. Texture was scored on a scale of 5-1, where 5 = very firm, 3 = moderately firm, and 1 = very soft. Colour was also scored on a scale of 5-1, where 5 = very attractive, 3=acceptable, and 1= unattractive. Evaluation forms with instructions were provided to each panelist.

2.6 Data Analysis

One way analysis of variance (ANOVA) was performed on the data collected over the 5 day period and the means of the three replicates of treatments tested by Duncan's Multiple Range Test (DMRT) to determine the differences of the mean scores for browning, texture and colour at P = 0.05 using SPSSv16 (SPSS software for Windows, release 16.0, SPSS Inc., USA).

ISSN 2348 – 7968

3. Results and Discussion

3.1 Overall effect of brine on browning, texture and colour

Salt is widely used as a preservative in the food industry both in solid form and as a solution. It is relatively inexpensive and an easy way of preserving vegetables. The resulting product is either salty or acidic, both of which most people like. There were significant differences ($P > 0.05$) among treatments in all the three parameters tested; browning (P= 0.010; 6.8±3.76) ; texture (P= 0.000; 5.7±2.80) and colour (P=0.000; 5.4±2.69). This showed the positive preservative impact of salt solution in extending the shelf life of lettuce.

The strong brines 20% and 25% were effective in reducing browning and maintaining texture and colour followed in sequence by control (0%) >15% > 10% > 5%. The strong brines (20% and 25%) preserved the measured parameters probably due to the process of osmosis, since water in the lettuce was replaced by the brine owing to differences in concentration.

Table1: Mean Scores of three Replicates and Standard Deviations of the Observed Parameters at various Concentration

Conc. (w/w)	Browning	Texture	Colour
Control (0%)	6.6 ± 3.57^{e}	7.0 ± 3.16^{c}	5.8 ± 3.34^{a}
5%	4.8 ± 4.02^{b}	3.4 ± 0.89^{d}	3.4 ± 0.89^{c}
10%	4.6 ± 3.57^{b}	3.0 ± 0.00^{d}	3.4 ± 0.89^{c}
15%	4.6 ± 3.57^{b}	3.8 ± 1.09^{d}	3.4 ± 0.89^{c}
20%	10.2 ± 1.09^{a}	8.6 ± 0.89^{b}	7.8 ± 1.76^{e}
25%	10.2 ± 1.09^{a}	8.6 ± 0.89^{b}	8.6 ± 0.89^{e}

Scores along the same column with the same superscript are not significantly different ($P < 0.05$)

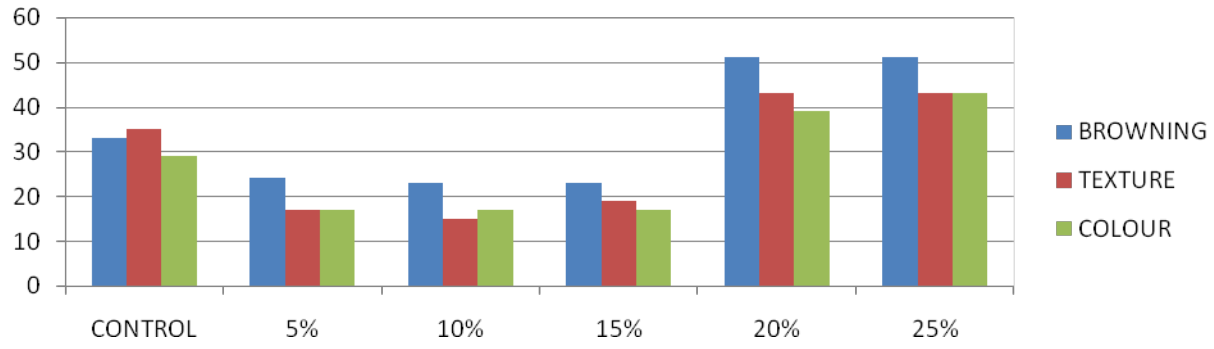

Figure 1: Panelists' overall assessment of the effect of the treatments on the three measured parameters

3.2 Browning

Agricultural practices, soil, fertilizers, climate and harvesting conditions all affect the rate of leaf surface and edge browning. Browning was not observed in all the treatments on the first 24 hours of storage. The severity of browning was significantly lowered and maintained with the 20% and 25% treatments while the 5%, 10% and 15% treatments could not protect the samples against browning after the first day of storage. Browning was however appreciating daily in the control after 24 hours of storage.

ISSN 2348 – 7968

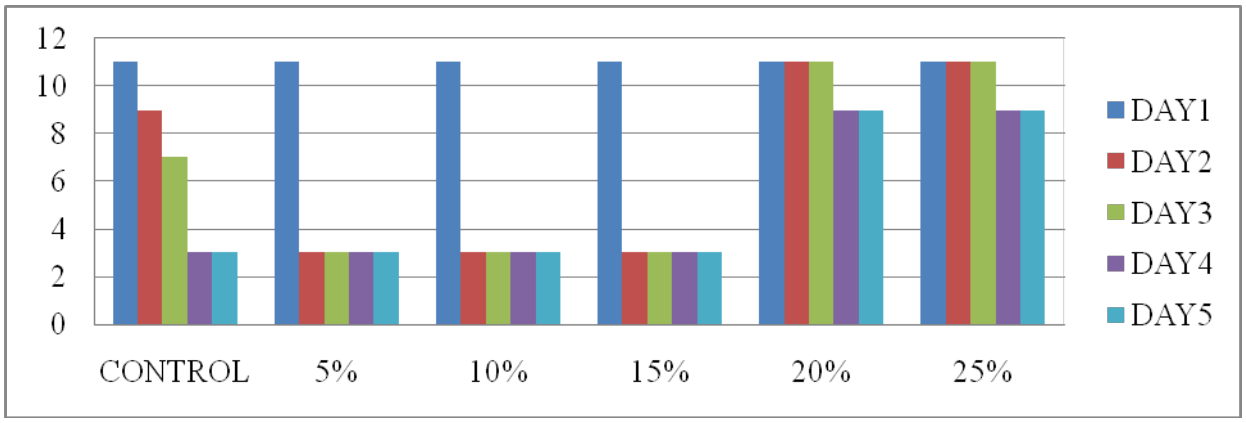

Figure 2: Panelists' daily assessment of treatment effect on leaf surface and edge browning of stored lettuce.

3.3 Texture

The texture played an important role in acceptability of the lettuce. Meilgaard *et al*., (2007) indicated that texture is the sensory manifestation of the structure or inner makeup of foodstuffs in terms of their reactions to stress, which are measured as mechanical properties (such as firmness) by the kinesthetic sense in the muscles of the fingers.

Texture denoted by firmness deteriorated at a constant rate on a daily basis in the control (0%) while declining drastically in the 5%, 10% and 15% treatments after the first day of storage. The 20% and 25% treatment maintained an equally acceptable texture.

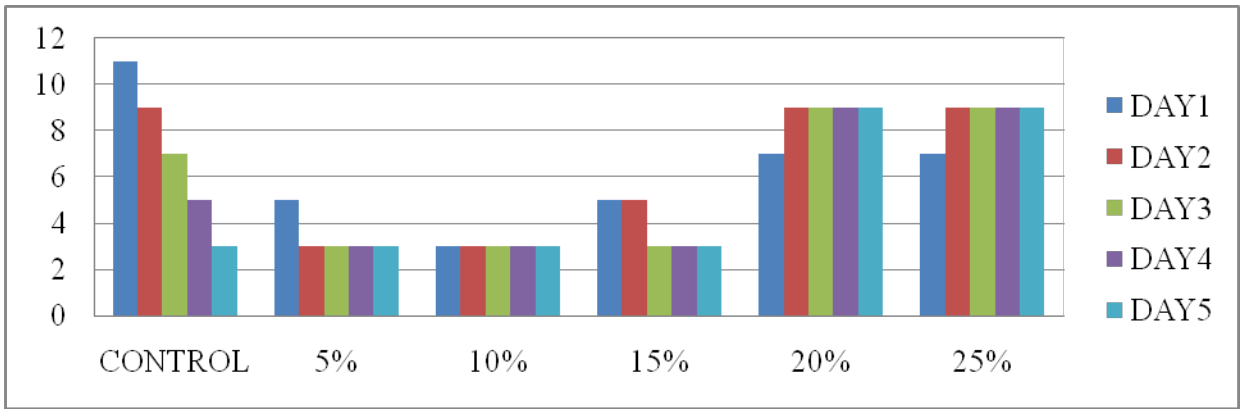

Figure 3: Panelists' daily assessment of treatment effect on texture of stored lettuce

3.4 Colour

Colour serves as a preliminary parameter for the acceptance of lettuce and indicates its fitness for consumption. The control (0%) was not significantly different from the rest of the treatments and was effective in maintaining colour for the first 24 hours of storage before colour started to deteriorate. The strong brine of 20% and 25% were effective in maintaining lettuce colour for the entire period after 48 hours of storage while the panelists rated the 5%, 10% and 15% as the least protective of colour.

ISSN 2348 – 7968

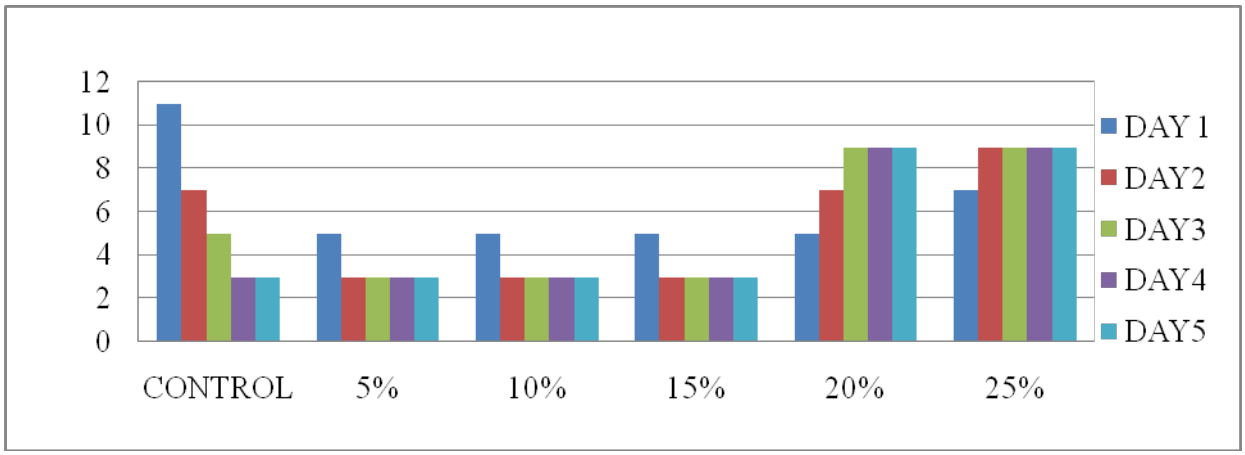

Figure 4: Panelists' daily assessment of treatment effect on colour of stored lettuce

4. CONCLUSION

In considering the overall possibilities of brine preservation as a method of shelflife extension for vegetables including lettuce, several factors will have to be considered. Not considering only the advantages and disadvatages of the method, but also quality of the product produced under the varying brine concentrations. The experiment indicated that brine at strong levels of concentration can be satisfactorily employed as a shelf life extension method for lettuce, with minimal effects on its hedonic properties. Brine preservation of lettuce therefore deserves consideration.

REFERENCES

[1]. Fraser, A.M., (2005). Preservation of Vegetables by Salting or Brining: In *Farmers Bulletin No. 1932 authored by John L. Etchells, Ivan D. Jones, June, 1944*

[2]. Khadre, M. A., A. E. Yousef, and J. G. Kim. (2001). Microbial aspects of ozone applications in food. J. Food Sci. 66:1242-1252.

[3]. King, A. D., J. A. Magnuson,, T. Torok, and N. Goodman. (1991). Microbial flora and storage quality of partially processed lettuce. J. Food Sci. 56: 459-461.

[4]. Labeda A., Ryder E.J., Grube R., Dolezalova I., and Kristkova E. (2007): Lettuce (Asteraceae; *Lactuca* spp.). In: SINGH R.J. (ed.), Genetic Resources, Chromosome Engineering, and Crop Improvement, Vol. 3, Vegetable Crops. Boca Raton, CRC Press, Tailor and Francis Group: 377–472.

[5]. Meilgaard M.C, Civille G.V, Carr B.T (2007). *Sensory Evaluation Techniques.* 4th ed. Boca Raton, FL: CRC Press.

[6]. Peryam, D. R. and Girardot, N. F. (1952). Advanced taste test method. Food Eng, 24, 58-61:194.

[7]. Ragaert, P., Verbeke, W., Devlieghere, F., Debevere, J. (2004). Consumer perceptionand choice of minimally processed vegetables and packaged fruits. Food Qual. Prefer.15, 259-270.

[8]. Rico, D., Martin-Diana, A.B., Barat, J.M., Barry-Ryan, C. (2007). Extending and measuring the quality of fresh-cut fruit and vegetables: a review. Trends Food Sci.Tech. 18, 373-386.

[9]. Rubatzky, V.E. and Yamaguchi, M.(1997): World Vegetables. New York, Chapman & Hall

[10]. Sapers, G. M. (2003). Washing and sanitizing raw materials for minimally processed fruit and vegetable products. In *Microbial safety of minimally processed foods*; Novak, J. S., Sapers, G. M., Juneja, V. K., Eds.; CRC Press: Boca Raton, FL, London, New York, Washington, DC; pp 221-253.

[11]. Stone, H and Sidel, J.L. (2004). *Sensory Evaluation Practices.* 3rd ed. San Diego, CA: Academic Press.

[12]. Tomas-Barberan, F. A.., Gil, M. I.., Castaner, M., Artes, F. Saltveit, M. E.(1997). Effect of selected browning inhibitors on harvested lettuce stem phenolic metabolism. *J. Agric. FoodChem.* 45:583-589.

ISSN 2348 – 7968

[13]. USDA Nutrient Data Laboratory (2004). National Nutrient Database for Standard Reference, Composition of foods raw, processed and prepared. http://www.nal.usda.gov/fnic/foodcomp.