PHYSICOCHEMICAL AND COLORIMETRIC PROPERTIES OF GREEN PEPPER (*CAPSICUM ANNUUM* L.) PUREE

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Abstract
Pepper (Capsicum annuum L.) puree is an important food ingredient. The packaging material and shelf-life stability of green pepper puree was studied over a period of 27 days in three temperature treatments conditions as room temperature (30±2°C), air condition temperature (20°C) and climatic chamber temperature (4°C). The green pepper puree was prepared in salt and oil in 1 and 5% concentrations pasteurised and stored in plastic and glass containers. The colour changes, pH, Total Soluble Solids (TSS) and Total Titratable Acids (TTA) were considered over the storage period. The addition of 1% salt or 5% oil to the puree caused a marked alteration in pH, TTA and colour parameters (L a* b*) but not TSS. Over the storage period of 27 days, the pH and TTA differed significantly ($p<0.05$) among salt and oil purees with the latter having a higher pH and TTA. Storage condition did not influence these two indices but among packaging materials, glass showed ($P<0.05$) to better stabilize pH compared to the plastic material. TSS was fairly stable among the different packaging materials but was greatly reduced by storing at a higher temperature. At the end of the storage period, 5% oil puree was lighter in colour than 1% salt. Greenness of the purees remained stable over the period while yellowness reduced drastically by the final week of storage. Packaging and storage conditions did not influence colour parameters over the assessment period.*

Keywords: *Capsicum annuum*, pepper puree, salt, oil, packaging material

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1. INTRODUCTION

Pepper (*Capsicum* spp.) is often described as the "king of spices" and used as a flavour in foods. Capsicum belongs to the family *Solanaceae* (Night shade) and are mostly herbs or under herbs while some others are climbers. *Capsicum* contains about 90 genera and nearly 3,000 species (Vidyyarltie and Tripathi, 2002; Stern, 2000). There are numerous species of pepper (*Capsicum* spp.). The most common varieties are *Capsicum annuum, Capsicum baccatum, Capsicum chinense, Capsicum pubescens* and *Capsicum frutescens.* According to Messraen (1992), *Capsicum annum* is not known in a wild state and species cultivated are commonly known as sweet pepper, bell pepper, cherry pepper and green pepper. In the tropics, pepper is mostly cultivated as rain fed crop but also in other regions as an irrigated crop (Maiti and Kumari, 2002). Pepper can be green, red, orange or yellow depending on the state of ripeness or level of maturity or the variety. Fully ripe peppers are slightly sweeter and have higher vitamin content than immature green pepper (Anonymous, 2009).

The most important characteristic feature of pepper is its hotness caused by the active ingredient, capsaicin, which is concentrated in the seeds and ribs of pepper (Anonymous, 1998). Pepper contains numerous chemicals that are importance for its nutritional value, taste, colour, aroma and antioxidant value. Chilli pepper contains, carbohydrate, protein, total fat and dietary fiber and no cholesterol. Among vitamins identified are vitamins A, C, E and K, thiamin, riboflavin, pyridoxine, pantothenic acid, niacin and folates. Minerals identified included calcium, copper, iron, magnesium, phosphorus and selenium (Mehmet *et al*., 2006). Other components identified are water, carotenoids, resin, terpenoid and piperine (Yeager, 1998).
The health application of pepper is enormous. It has been used over the years as natural remedies for coughs, colds, sinusitis, bronchitis, ulcers and pain relief (Yeager, 1998). It is a major component in ointment for the relief of arthritic and neuropathic pains Nwachukwu (2007). According to Yeager (1998), capsaicin in peppers has anti-bacterial, anti-carcinogenic, analgesic and anti-diabetic

properties and help reduces low density lipoprotein (LDL) cholesterol, the type that causes diseases like stroke, high blood pressure and heart diseases.

A study by Joo *et al*. (2010) indicated that capsaicin is even capable of preventing the production of fat by stimulating production of proteins that break down fat and inhibiting the actions of those that produce fat. In the culinary sector, pepper is used in several dishes including curries, pizzas, meat and fish dishes, desserts as vital components of our diets. In salad preparations, pepper is an important vegetable (Remison, 2005; Fox *et al*., 2005).

Paprika, which is a derivative from pepper is a mild red spice used primarily in the flavouring of garnishes, pickles, meats, barbecue sauces, ketchup, cheese, snack food, salads and sausages (Bosland, 1996). Pepper, is presently used in the production of ginger ale and ginger beer (Remison, 2005).

The postharvest handling of pepper is important to reduce its postharvest losses. Utilisation of pepper as a fresh commodity or processed requires appropriate postharvest handling to ensure quality product. Processing or preservation of pepper involves cleaning, packaging, storage and marketing of the pepper as fresh produce, canned, brined/pickled, frozen, fermented or dehydrated forms. Fresh peppers may be stored for up to 3 weeks in cool, moist conditions of about 45 to 50°F temperature and 85 to 90% relative humidity (Maiti and Kumari, 2002). Although *Capsicum annuum* is an economic value crop, its postharvest losses are high when fully ripe. Addressing this challenge, mature unripe green pepper (*Capsicum annuum*) was processed into puree in vegetable oil and sodium chloride and their physicochemical properties evaluated over a period of 27 days.

2. MATERIALS AND METHODS

2.1 Development of green pepper puree

Freshly harvested physiological matured green pepper (*Capsicum annuum* L.) was obtained from a farm in the Eastern Region of Ghana. The fresh pepper was sorted, destalked and washed in distilled water. The cleaned green pepper was then washed in 1% sodium metabisulphite to remove any microbial load and subsequently washed in potable water to remove traces of sodium metabisulphite. The green pepper was milled into a smooth puree using a blender (Model 32BL79, Dynamics Corporation of America, New Hartford, Connecticut USA) at a ratio of 1:2 of pepper and distilled water.

2.2 Packaging material

The prepared puree was then pasteurized and stored in plastic and glass containers and kept at three temperature conditions of room temperature (30±2°C), air condition temperature (20°C) and climatic chamber temperature (4°C) for a period of 27 days. The three selected temperature conditions of 30±2°C, 20°C and 4 °C simulated green pepper puree stored in an environment without an air conditioner, with an air conditioner and in a refrigerator, respectively.

2.3 Development of green pepper puree in salt (sodium chloride) or oil

Sodium chloride (1% w:w) was added to the developed puree before pasteurization to obtain green pepper puree samples in salt. Similarly, vegetable oil (5% w:w) was added to the developed puree to obtained green pepper puree in vegetable oil for subsequent studies.

2.4 Physicochemical determination

Total Soluble Solids (TSS) of the purees defined as °Brix was determined using a Grant Refractometer RB62 (HANNA Instruments, Germany). The refractometer was initially calibrated with distilled water and sucrose solutions before the determinations in triplicates. The pH of the purees was measured using a 3330 Research pH Meter (Jenway Ltd., Essex, UK) by weighing 10.0g of the puree and subsequently dissolved in 100ml of distilled water. The mixture was allowed to stand for 1h and stirred before electrode was inserted for pH values. Total Titratable Acidity (TTA) was determined by titrimetry (Sadler and Murphy, 2010). An extract of the pepper puree (20ml) was titrated against NaOH (0.1N) to a faint pink endpoint, using phenolphthalein as indicator, and the acidity expressed as citric acid (Bozkurt and Erkmen, 2004; Gabaldon-Leyva, 2007).

2.5 Colorimetry

Colour measurements of sample was conducted using a Minolta Chroma Meter (Model CR 310, Minolta Camera Co. Ltd. Japan), based on the *L* a* b** colour system in triplicates. The Chroma meter was calibrated with a standard white tile (*L** = 97.63 *a**=-0.48 *b** = +2.12) as described in the Hunter Laboratory Manual (Hunter, 2001) before colour measurement of purees were taken.

2.6 Experimental design

A ratio of 1:2 freshly harvested green pepper and potable water was used to develop green pepper puree. A factorial design of 2 x 2 x 3 employed salt and oil puree, stored in plastic and glass containers and kept at room temperature (30 ± 2°C), air condition temperature (20°C) and climatic chamber temperature (4°C) for a period of 27 days. The experiment was conducted in triplicates. Thirty-six samples were withdrawn per day for analysis. Six withdrawals were done over a period of 27 days consisting of four withdrawals in the 1st and 2nd week of storage at two days intervals. One withdrawal each was conducted on the 3rd and 4th week of storage at seven days interval. Based on the design a total of 216 samples were withdrawn for analysis during the period. The study employed green pepper puree without salt or oil as a control sample.

2.7 Statistical analysis

The Statistical Analysis Systems version 9.1 software packages were used to statistically analyze the data obtained for all treatments. Significance of treatment means was tested at $p = 0.05$ probability level using Duncan's New Multiple Range Test (DNMRT).

3. RESULTS AND DISCUSSION

3.1 Physicochemical and colorimetric indexes of green pepper puree

Total soluble solids (TSS), pH, Total Titratable Acidity (TTA) and colour parameters of the green pepper purees are presented in Table 1. The pH and TSS content of the products are comparable to that obtained by Ahmed *et al*. (2002) for green chilli puree of pH 5.08 and TSS of 4.8. The TSS of control sample and the two treatments did not differ significantly ($p>0.05$). Addition of salt and oil treatments did not change the TSS of pepper puree but rather caused a change in pH, TTA and colour parameters. The treatments resulted in a decrease in pH for 1% salt and a further decrease for 5% oil (Table 1). This reduction in pH as a result of adding salt to the pepper puree is similar to earlier observations by Bozkurt and Erkmen, (2004) although different quantities of salt was reported in their study. Comparing the purees, 1% salt puree had the lowest TTA while 5% oil puree had the highest TTA. This observation shows that some organic acids from the oil contributed to the increase in TTA and reduction in pH of puree with 5% oil.

Colour is one of the most essential attributes of products. It influences products visual impression and contribute immensely to its acceptability or rejection (Maskan, 2001). The colour of the control samples and treatment samples were green, typical of matured green pepper. Green pepper contains chlorophyll and carotenoids which are responsible for its green colour (Marin *et al*., 2004). Table 1 show that raw pepper puree, which served as control had a brighter colour compared to the purees in 1% salt and 5% oil. The puree containing 5% oil had the lowest L* value compared to 1% salt. The addition of salt and the oil probably decreased the opacity of the puree, making it darker than the control (Mehdizadeh *et al.*, 2012; Farroni and Buera, 2011). Therefore, addition of oil decreased light penetration of the oil puree compared to the salt puree, thus samples with 5% oil had lower L* value than the others.

The a* and b* colour values indicates that the colour of the purees lie within the green and yellow regions of the colour spectrum. Treatment with 1% salt was significantly ($p < 0.05$) less in green than the control and 5% oil, while the 5% oil was the most yellow, compared to the other puree samples (Table 1). A decrease in green with the addition of salt has also been observed in other products Topno *et al.* (2013). However, in studies by Lau *et al.* (2000) and Ahmed *et al*. (2002) the attractive green colour of green plant products could be retained by controlling the degradation of chlorophyll into pheophytin during thermal processing. Additionally, thermal processing may lead to a considerable darkening of products. The higher yellowness of samples with 5% oil could be the result of the yellowish sheen of the vegetable oil used in the study.

3.2 Physicochemical and colour properties of pepper puree in storage

Physical and chemical properties of the purees during the period of storage are presented in Table 2. Within the storage period some puree samples were lost and were therefore discarded and excluded from the analysis. Generally, the pH of the pepper puree from 1% oil and 5% salt showed significant differences ($p<0.05$), with samples containing 1% salt having relatively lower pH as presented in Table 2. However, the pH of purees did not change significantly over the storage period of 4 weeks with packaging material and storage condition.

For puree samples treated with 1% salt the pH significantly ($p<0.05$) increased in the plastic packaging compared to glass. This increase in pH could be attributed to the breakdown of some organic acids and a subsequent formation of basic compounds (Bozkurt and Erkmen, 2004). This decomposition must have occurred considerably in plastic packaging than glass which is inert and impermeable to moisture and gases. The same observation, however, was not recorded for pepper puree treated with 5% oil. Storage condition did not have a significant influence on the pH of pepper puree. Generally, a steady reduction in TTA in the pepper puree samples over the 4-week storage period was realized. Purees treated with 5% oil had significantly higher acidity than 1% salt. The acidity of the oil, as a result of the production of free fatty acids and other organic acids in the course of storage probably influenced this occurrence. Packaging material and storage condition on the other hand had no significant effect on the TTA.

TSS was relatively stable over the study period, showing no remarkable change with regards to packaging material but differed significantly ($p<0.05$) in the case of storage condition and treatment for salt or oil. Storage under room temperature (R) saw the most profound decrease followed by air condition temperature (AC) and the least in climatic chamber (CC). Under room conditions, °Brix ranged between 3.0-5.0 while AC and CC ranged between 3.2-5.0 and 3.8-5.4, respectively (Table 2).

Table 1: Physicochemical and colour indexes of green pepper puree

Sample	Parameter					
	TSS	pH	TTA	L*	a*	b*
Control	4.0 ± 0.0^a	5.55 ± 0.01^a	0.073 ± 0.001^a	51.73 ± 1.07^a	-7.98 ± 2.16^a	8.26 ± 2.70^a
1% Salt	5.0 ± 0.1^a	4.97 ± 0.01^b	0.068 ± 0.001^b	49.39 ± 0.35^b	-5.69 ± 0.16^b	8.15 ± 0.29^a
5% Oil	4.0 ± 0.1^a	5.33 ± 0.01^c	0.079 ± 0.002^c	49.08 ± 0.14^b	-9.62 ± 0.04^a	12.23 ± 0.22^b

Within the same column, means bearing different superscripts are significantly different at 5% significance level

Table 2: Quality properties of pepper puree during 4-week storage period

	Treatment			Physicochemical			Colour		
	Day	Packaging	Storage Condition	TSS	pH	TTA	L*	a*	b*
1% salt		Glass	*R	5.0±0.2	4.91±0.02	0.077±0.007	49.053±0.073	-4.548±0.061	12.108±0.110
			CC	5.0±0.0	4.99±0.01	0.081±0.003	48.468±0.116	-6.070±0.093	14.200±0.160
	3		AC	4.9±0.1	4.99±0.07	0.070±0.001	48.345±0.073	-5.533±0.099	13.925±0.112
		Plastic	R	5.0±0.1	5.22±0.06	0.072±0.007	49.285±0.315	-4.433±0.252	11.550±0.189
			CC	4.9±0.1	5.07±0.07	0.087±0.006	48.315±0.253	-6.335±0.187	13.150±0.338
			AC	5.0±0.2	4.95±0.01	0.077±0.001	47.815±0.042	-5.628±0.065	12.388±0.082
		Glass	R	5.0±0.2	4.88±0.01	0.064±0.004	49.195±0.085	-4.328±0.109	11.923±0.254
			CC	5.0±0.2	5.02±0.01	0.072±0.001	48.508±0.205	-5.465±0.172	13.748±0.451
	6		AC	5.0±0.2	4.88±0.01	0.063±0.004	49.015±0.025	-5.015±0.057	13.045±0.134
		Plastic	R	4.0±0.1	5.31±0.01	0.064±0.002	50.688±0.145	-5.258±0.036	13.543±0.062
			CC	5.0±0.1	5.06±0.01	0.090±0.003	47.703±0.200	-6.365±0.196	12.818±0.311
			AC	5.0±0.2	5.03±0.01	0.070±0.003	48.100±0.124	-5.145±0.052	12.815±0.095
		Glass	R	5.0±0.1	4.93±0.03	0.072±0.002	51.645±0.052	-3.920±0.039	10.623±0.115
			CC	5.0±0.1	4.94±0.02	0.086±0.004	50.155±0.281	-4.878±0.117	11.370±0.050
	8		AC	5.0±0.1	4.90±0.01	0.073±0.002	50.055±0.068	-4.575±0.047	11.380±0.071
		Plastic	CC	5.0±0.1	4.99±0.01	0.082±0.001	50.738±0.238	-4.840±0.199	10.283±0.086
			AC	5.0±0.1	4.97±0.01	0.081±0.003	50.925±0.116	-3.633±0.096	10.173±0.109
		Glass	R	3.0±0.1	5.02±0.01	0.085±0.001	50.935±0.060	-2.980±0.203	11.860±0.105
	15		CC	5.1±0.1	5.10±0.01	0.078±0.003	48.393±0.023	-4.898±0.042	13.165±0.061
		Plastic	CC	5.1±0.2	5.10±0.10	0.128±0.007	48.778±0.061	-5.445±0.078	12.910±0.069
	27	Glass	R	5.0±0.1	4.77±0.01	0.074±0.001	53.283±0.417	-0.723±0.183	7.438±0.445
			CC	5.0±0.1	4.87±0.02	0.070±0.003	51.610±0.045	-2.558±0.023	10.040±0.082
5% oil		Glass	R	3.9±0.0[a]	5.20±0.01[b]	0.073±0.001[b]	49.223±0.067[a]	-5.513±0.036[a]	14.013±0.088[a]
			CC	4.0±0.1	5.37±0.01	0.078±0.003[b]	50.378±0.038	-6.163±0.053	13.678±0.047
			AC	4.0±0.0	5.42±0.01	0.082±0.001[b]	48.948±0.130	-5.603±0.126	14.078±0.176
	3	Plastic	R	4.0±0.1	5.46±0.05	0.095±0.002b	49.365±0.088	-6.275±0.017	13.908±0.046
			CC	4.0±0.1	5.41±0.01	0.073±0.004b	51.333±0.099	-7.978±0.157	14.725±0.134
			AC	3.9±0.1	5.48±0.01	0.082±0.001b	49.170±0.089	-6.488±0.078	13.708±0.121
		Glass	R	3.8±0.2	5.53±0.02	0.096±0.002b	49.663±0.098	-5.550±0.060	15.585±0.159
			CC	5.4±0.3	5.39±0.01	0.077±0.001b	50.773±0.101	-6.370±0.215	15.300±0.303
	6		AC	3.3±0.1	5.39±0.01	0.079±0.003b	49.513±0.089	-5.685±0.013	15.525±0.080
		Plastic	R	3.4±0.1	5.72±0.01	0.099±0.003b	48.655±0.037	-4.568±0.045	12.665±0.102
			CC	3.8±0.2	5.43±0.01	0.083±0.004b	51.235±0.211	-7.735±0.259	14.665±0.366
			AC	3.6±0.3	5.26±0.01	0.085±0.007b	50.783±0.148	-6.480±0.046	15.383±0.088
		Glass	R	3.0±0.3	4.83±0.01	0.129±0.004b	54.183±0.069	-4.625±0.057	13.115±0.103
			CC	3.8±0.1	5.37±0.01	0.081±0.002b	52.558±0.173	-5.423±0.243	12.775±0.258
	8		AC	3.2±0.2	5.78±0.02	0.064±0.004b	51.568±0.086	-5.153±0.046	13.488±0.114
		Plastic	CC	4.0±0.1	5.39±0.01	0.092±0.001b	52.640±0.158	-6.380±0.165	11.815±0.096
			AC	3.4±0.1	5.63±0.01	0.087±0.001b	51.185±0.063	-5.478±0.025	13.653±0.026
	15	Glass	CC	4.0±0.2	5.48±0.01	0.100±0.001b	51.698±0.215	-6.163±0.149	14.418±0.206
		Plastic	CC	4.1±0.4	5.52±0.01	0.083±0.004b	50.368±0.060	-7.015±0.030	14.730±0.096
	27	Glass	CC	3.8±0.1	5.28±0.01	0.070±0.001b	52.385±0.061	-3.725±0.016	10.828±0.109

*R=Room, CC= Climatic chamber, AC= Air conditioned

Interesting, the difference between storage under AC and CC was not significant ($p>0.05$). A significant reduction of °Brix in purees with 5% oil was observed over time but not for samples containing 1% salt (Table 2). However, pepper does not contain starch to sustain the synthesis of soluble sugars and so an increase in TSS was not expected in any of the purees. The fairly steady pH and reduced acidity is indicative of the fact that fermentation did not occur in the pepper puree during storage. Colour loss or degradation is considered undesirable since it may lead to the rejection of a product. This

may result from browning reactions or breakdown of colour pigments into other forms. The behaviour of pepper puree colour in storage is also presented in Table 2. The L* value was considerably different between 1% salt and 5% oil, with 5% oil being less coloured. However, storage condition and packaging material did not impact more colour to the pepper puree samples over the study period. Overall, L* value showed a drift toward less colour during the third and fourth weeks of storage. Redness-greenness of the purees remained stable without marked change ($p > 0.05$) observed for the different treatments, packaging material or storage condition. This suggests that there was not any significant breakdown of green colour compounds in the puree during storage. The observation also downplays the formation of brown pigments through browning reactions and ascorbic acid oxidation in purees during storage (Bozkurt and Erkmen, 2004). The yellowness or blueness, unlike red-green changed markedly over the storage period. The b* value increased during storage (non-linear) however, its value reduced sharply in the fourth week. This reduction is indicative of loss in the yellowness of the purees in storage which is probably due to oxidation of yellow colour compounds (Ahmed, 2004).
Changes that occurred in colour of the purees, nonetheless, were not influenced by packaging material or storage condition, contrary to what have been reported in other studies (Ahmed and Shivare, 2001; Sigge *et al.*, 2001; Silvica *et al.*, 2011). For retention of green colour, low temperature storage has been suggested by Sigge *et al.* (2001).

4. CONCLUSIONS

Pepper purees at reduced temperature of storage in glass containers showed good shelf-stability. Although some physico-chemical properties changed over the period of storage, colour (greenness) of the purees remained relatively stable and was not influenced by packaging or storage condition.

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