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Effect of TSS and temperature on the density of Gongura leaves puree.

[1] Jagamohan Meher, [2] Amit Keshav, [3] Bidyut Mazumdar, [4] Alok Sharma
[1][2][3][4] National Institute of Technology Raipur, Chhatisgarh (India)

Abstract- **The effect of temperature and TSS on the density of Gongura leaves purees are reported. The densities of the gongura puree were determined at TSS (1.6-5.60brix) and temperatures of between 10 and 60^{0}C with 10^{0}C increments. The density of Gongura puree was strongly affected by TSS, while it was relatively less affected by temperature. Different mathematical models are try to fits the the results obtained as a function of temperature and density with varying TSS but linear model fitted best with R^2>0.97.**

Key words: **Gongura puree, Density, Temperature, TSS.**

I. INTRODUCTION

Gongura leaf is a species of hibiscus. The leaves are deeply 3-5 lobed, 8-15 cm long arranged alternately on the stems. The plant is grown in all parts of the world; it is a native to India but was introduced to other parts of the world such as Central America, West Indies, and Africa. Moreover, in most of the countries, it is called as 'Roselle'. The fresh leaves used completely, crushed, or chopped in different foods because of its sore nature. Roselle is used in jams, jellies, sauces, and wines. The young leaves and tender stem are eaten raw in salads and chutney. They are also added to curries and some Malaysian dishes as a seasoning. Roselle can prevent cancer, lower blood pressure and improve the digestive system in humans (Muhammad and Shakib (1995)). Its calyx extract has also been used as an effective treatment for patients with kidney stones due to its uricosuric effect (Kukongviriyapan, 2008). One of the most widely consumed gongura leave based products is chutney that is widely consumed in breakfast in south India. Gongura chutney is prepared by crushing the leaves by using mixer grinder until desired consistency reached.

In spite of their vast usages, the consumption of the leaves is limited because of its perishable nature and short shelf life. However, its dried form has inferior aroma and color so it's generally not preferred.so preservation of the fresh form of leaves is essential for taking care of its color, aroma and nutrient content. But while taking care of the quality factors conventional techniques for preservation of the leaves like sun-drying, salting etc are not suitable. With an increase in civilization, there is increasing demands of better quality of foods both satisfying nutritional benefits along with being economical. So *Thermal* treatment of foods Processing constitutes an important and most widely adopted process for microbial inactivation used for preservation technique in the food industry (Ercan et al., 2013).

Physical properties of foods are fundamental parameters used in the designing and calculations of both equipment and control processes. They are also very important for the developing of new industrial products with desired properties or for quality improvement of already existing ones. The transport phenomena (momentum, heat, and mass) can be applied for determining the efficiency of food systems if engineering data are available. The density of vegetable gongura puree(concentrate and intermediate products), is greatly affected by both solids content and temperature. For this reason, it becomes essential to get to know the physical property values of vegetable gongura puree as a function of temperature and TSS.

For grape juice, different authors working with different varieties of grapes, TSSs, and temperatures have measured density data. Constenla (1989) proposed empirical equations that related the density with TSS and temperature for the juice of apple (Malus domestica) and Miguelsanz studied the variation of the density of a depectinised and clarified pear juice with temperature and soluble solids The objectives of this study were to find out the heat stability of the chlorophyll pigment during different blanching media. A more extensive study on the effect of temperature and TSS on the density of Gongura puree are reported in this paper. The aim of this research is to determine the density of Gongura leaves puree

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and to model the effect of temperature (10–60^{0}C) and TSSs (1.6–5.6^{0}Brix).

2. EXPERIMENTAL PROCEDURE

2.1 Preparation of puree

The fresh Gongura was procured from a local market in Chhattisgarh. Vegetables were cleaned under distilled water. An adequate amount of distilled water was transferred into a container and heated to the desired temperature (90^{o}C) for blanching of vegetable leaves. A known quantity of leaves was submerged in excess of water and subjected to blanching in the respective blanching media for 5 min. Effectiveness and time of blanching were determined by peroxidase inactivity test. After blanching, the leaves were immediately cooled to room temperature (301K) by soaking in ice-cold water.

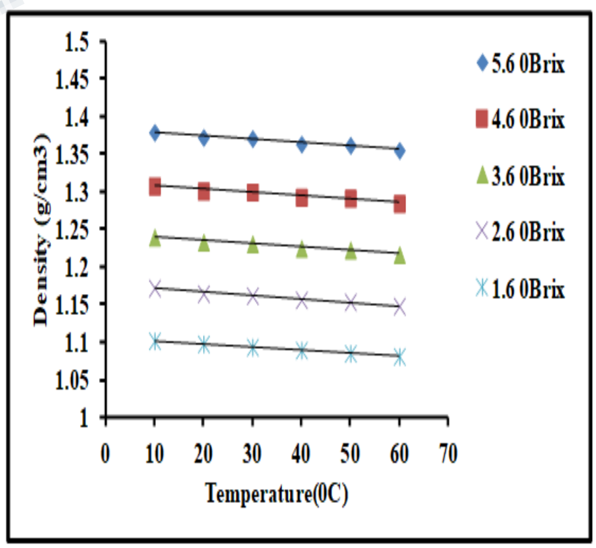
Blanched vegetable was ground in a wet grinder (Remi Lab Equipment, India) for a specified amount of time until puree is formed. The pureed material was then passed through the mesh sieves size of 14 m to obtain a puree of uniform consistency. Samples used were obtained from gongura leaves , with a TSS of 5.6◦Brix. Chlorophyll content was analyzed using the method described by Arnon, (1949). Samples of 1.6, 2.6, 3.6 and 4.6 ◦Brix were obtained by dilution of the original puree concentrate with distilled water. TSS contents were measured in triplicate as◦Brix, using a digital refractometer (Atago Company Ltd., Japan) at 30◦C.

Density data were measured by pycnometers of 25 ml capacity at temperatures from 10 to 60^{0}C, at 10 ^{0}C intervals. In order to verify possible changes in their volume due to thermal expansion, each pycnometer had been previously calibrated with distilled water through a heating process, whereby the sample pycnometer was weighed at 10^{0}C intervals from 10 to 60^{0}C. A water bath was used to control the temperature. Pycnometers were filled with the Gongura puree and placed in the water bath until reaching the specified temperature. Pycnometers were then quickly weighed in an analytical balance with 0.0001 g precision. Measurements were made in triplicate at10, 20, 30, 40, 50 and 60^{0}Cwith of TSSs of 1.6, 2.6, 3.6 and 4.6 ◦Brix. Experimental data were fitted to four different models (linear, quadratic, exponential, exponential quadratic) using MS office 2007. In all cases, estimated parameters are given with their respective confidence intervals (p = 0.05), because of the standard error of estimates by the Student-t adjusted at the degree of freedom. Fitting accuracy was evaluated through the analysis of R^2 and the plot of prediction error.

3.RESULTS AND DISCUSSIONS

3.1. Effect of temperature and TSS on density of Gongura leaves puree

The experimental results obtained for the density of gongura puree at several temperatures and TSSs are shown in Table 1. Density values obtained for gongura puree can be compared with values obtained in previous studies as regards depectinised and clarified juices such as peach and orange juices, clear grape juice by Zuritz et al. According to the data presented in Table 1, increase in TSS and decrease in temperature result in density increase. As for all assayed temperatures, density was found to be strongly affected by puree TSS. As a case in point, at 10^{0}C, Gongura puree density increased from 1.102g/cm^3 at 1.6^{0}Brix TSS to 1.379 g/cm^3 at 5.6 ^{0}Brix, which involves an increase of 26.7%. Similar increases in density (around 26%) are observed in all assayed range of temperatures. However, these increases decrease slightly at a higher temperature. Consequently, through a TSS increase from 1.6 to 5.6 ^{0}Brix, densities at 60 ^{0}C were increased by 24.2%. Density was also slightly affected by temperature as, through a TSS of 5.6 ^{0}Brix, density decreased by 4.1% with a temperature increase from 10 to 60 ^{0}C. These resulting data seems to corroborate the



study of Zuritz et al. On clear grape juice whereby it was reported that, at 80◦C, density increased by 24.11% for a TSS increase from 22.9 to 70.6◦Brix. I was also stated that, with a

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TSS of 5.6 ^{0}Brix, density decreased by 2.69%, with a temperature increase from 10 to 60 ^{0}C.

Figure 1. Density of Gongura leaves puree at different TSS content as a function of temperature.

In order to model the single effect of temperature or TSS on density, experimental values were fitted to those models proposed by Aguado and Ibarz. who studied the variation of density with temperature and TSS in clarified apple juice. These models are linear, quadratic, exponential and quadratic exponential as shown in the Eqs. (1–4) below:

$$\rho = a + bX \quad (1)$$

$$\rho = a + bX + cX^2 \quad (2)$$

$$\ln \rho = a + bX \quad (3)$$

$$\ln \rho = a + bX + cX^2 \quad (4)$$

where ρ is density in g/cm3; a, b and c are constants; and X is the variable to model, temperature (◦C) or TSS (^{0}Brix). Equations that resulted in low residual square error were selected from the models for density variation in temperature and TSS. Finally, correlation coefficient and F values and the reliability interval for each of the variables were also calculated.

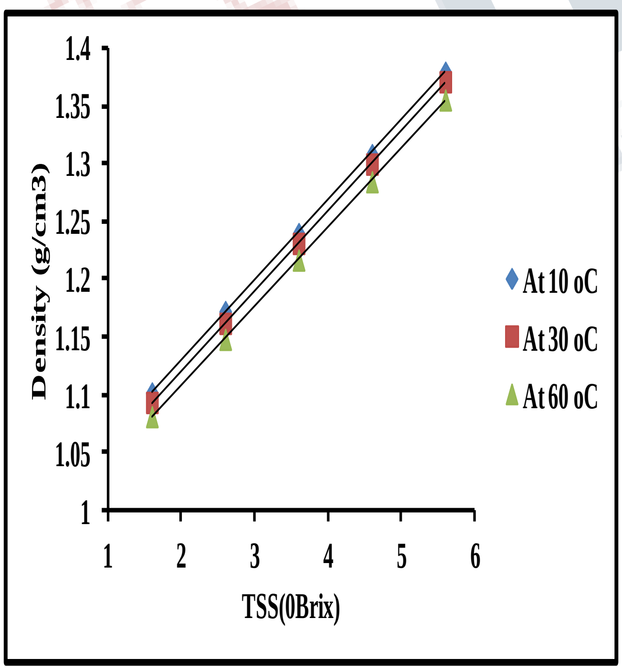

Figure 2. Density of Gongura leaves puree at different temperatures as a function of TSS

Table 1 Experimental values for density (in g/cm3) at different TSS and temperature for Gongura leaves puree.

Temperature (^{0}C)	Density (g/cm^3)				
	1.6 ^{0}Brix	2.6^{0}Brix	3.6^{0}Brix	4.6^{0}Brix	5.6^{0}Brix
10	1.102	1.1724	1.23984	1.30813	1.37933
20	1.098	1.164858	1.233416	1.301152	1.372576
30	1.09375	1.16215	1.23129	1.29988	1.37108
40	1.08975	1.156608	1.225166	1.292902	1.363726
50	1.0855	1.1539	1.22304	1.29163	1.36213
60	1.0815	1.148358	1.216916	1.284652	1.355376

Figure 1 shows that density decreased with increasing temperature for fixed TSSs. Experimental data were fitted to proposed models (Eqs. 1–4). Given the results obtained from the regression analysis, correlation coefficients were found to range in all cases from 0.9844 to 0.9999. In addition, values of parameter *a*, and absolute value of parameter *b*, increased with increasing TSS. Nonetheless, values of parameter *c*, in quadratic and exponential quadratic models, were eventually disregarded as they found insignificant (10^{-6} order) (Table 2). Then, quadratic and exponential quadratic models become linear and exponential models. Therefore, it may be suggested that a linear model, due to its appropriate fitting and simplicity, may help to predict density as a function of temperature. Concerning the effect of TSS, density variation under fixed temperature augmented with increasing TSS under a similar temperature effect (Fig. 2). Thus, a linear model can be proposed so as to predict gongura puree density as a function of TSS. According to Cepeda and Villarán, who reported these results at 25^{0}C, the density variation of clarified and depectinised juice of *Malus floribunda* with TSS is found to be linear.

Table 2 Fitting parameters for equations to predict the variation of density of Gongura leaves puree with temperature and TSS.

MODELS	^{0}Brix	a	-b*10^{-4}	C*10^{-6}	R^2
$\rho = a + bX$	1.6	1.10	4	-	0.99
	2.6	1.17	5	-	0.98
	3.6	1.24	4	-	0.98
	4.6	1.31	4	-	0.96
	5.6	1.38	5	-	0.97
$\rho = a + bX + cX^2$	1.6	1.10	4	0	0.99
	2.6	1.17	6	2	0.98
	3.6	1.24	5	0.3	0.98
	4.6	1.31	4	0	0.96
	5.6	1.38	4	-0.07	0.97
$\ln \rho = a + bX$	1.6	1.10	4	-	0.99
	2.6	1.17	4	-	0.98
	3.6	1.24	4	-	0.98
	4.6	1.31	3	-	0.96
	5.6	1.38	3	-	0.97
$\ln \rho = a + bX + cX^2$	1.6	0.10	4	-0.07	0.99
	2.6	0.16	5	1	0.98
	3.6	0.21	-0.0004	0	0.98
	4.6	0.27	-0.0003	0	0.96
	5.6	0.32	-0.0003	0	0.97

4. CONCLUSION

A mathematical model for the analysis of vegetable puree having different TSS was proposed. These models can be used for prediction of density of liquid puree, specially vegetable, based on composition and temperature, with high accuracy and without elaborate experimental work.

5. REFERENCES

1. Aguado, M.A.; Ibarz, A. Variación de la densidad de un zumo de manzana con la temperature y concentración. Alimentación, Equipos y Tecnología 1988, 209–216.

2. Constenla, D.T.; Lozano, J.E.Crapiste, G.H. Thermophysical properties of clarified apple juice as a function of TSS and temperature. Journal of Food Science 1989, 54 (3), 663–668.

3. Alvarado, J.D.; Romero, C.H. Physical properties of fruits I. Density and viscosity of juices as functions of soluble solids content and temperature. Latin American Applied Research 1989, 19 15–21

4. Cepeda, E.; Villaran, M.C. Density and viscosity of Malus floribunda juice as a function of TSS and temperature. Journal of Food Engineering 1999, 41 (2), 103–107.

5. Ibarz, A.; Miguelsanz, R. Variation with temperature and soluble solids TSS of the density of a depectinised and clarified pear juice. Journal of Food Engineering 1989, 10 (4), 319–323

6. Ramos, A.M.; Ibarz, A. Density of juice and fruit puree as a function of soluble solids content and temperature. Journal of Food Engineering 1998, 35 (1), 57–63.

7. Garza, S.; Reinoso, A.M.Ibarz, A. Effect of temperature on density of a concentrated pineapple juice. Alimentaria 2006, 374 100–101

8. Morales-Blancas, E.F., Chandia, V.E., and Cisneros-Zevallos, L., 2002. Thermal inactivation kinetics of peroxidase and lipoxygenase from broccoli, green asparagus, and carrots. Journal of Food Science, 67(1), pp.146-154.

9. Oboh, G., 2005. Effect of blanching on the antioxidant properties of some tropical green leafy vegetables. LWT-Food Science and Technology, 38(5), pp.513-517.

10. Chutintrasri, B. and Noomhorm, A., 2006. Thermal inactivation of polyphenol oxidase in pineapple puree. LWT-Food Science and Technology, 39(5), pp.492-495.

11. Dutta, D., Dutta, A., Raychaudhuri, U., and Chakraborty, R., 2006. Rheological characteristics and thermal degradation kinetics of beta-carotene in pumpkin puree. Journal of food engineering, 76(4), pp.538-546.

12. Rodrigo, D., Van Loey, A. and Hendrickx, M., 2007. Combined thermal and high-pressure color degradation of tomato puree and strawberry juice. Journal of Food Engineering, 79(2), pp.553-560.

13. Koca, N., Karadeniz, F. and Burdurlu, H.S., 2007. Effect of pH on chlorophyll degradation and color loss in blanched green peas. Food Chemistry, 100(2), pp.609-615.

14. Rudra, S.G., Sarkar, B.C. and Shivhare, U.S., 2008. Thermal degradation kinetics of chlorophyll in pureed coriander leaves. Food and Bioprocess Technology, 1(1), pp.91-99.

15. Ahmed, J., Shivhare, U.S. and Raghavan, G.S.V., 2000. Rheological characteristics and kinetics of color degradation of green chili puree. Journal of food engineering, 44(4), pp.239-244.

16. Ahmed, J., Shivhare, U.S. and Ramaswamy, H.S., 2002. A fraction conversion kinetic model for thermal degradation of color in red chili puree and paste. LWT-Food Science and Technology, 35(6), pp.497-503.

17. Ahmed, J., Shivhare, U.S. and Debnath, S., 2002. Colour degradation and rheology of green chili puree during thermal processing. International journal of food science & technology, 37(1), pp.57-63.

18. Negi, P.S., and Roy, S.K., 2000. Effect of low-cost storage and packaging on quality and nutritive value of fresh and dehydrated carrots. Journal of the Science of Food and Agriculture, 80(15), pp.2169-2175.

19. Naikwade, P., Mogle, U. and Jadhav, B., preservation of fenugreek by using improved traditional techniques.

20. Guiné, R.P., and Barroca, M.J., 2012. Effect of drying treatments on texture and color of vegetables (pumpkin and green pepper). Food and Bioproducts Processing, 90(1), pp.58-63.

21. Lebert, A., Therriault, P., Rocha, T. and Marty-Audouin, C., 1992. The drying kinetics of mint (Mentha spicata Huds.). Journal of food engineering, 17(1), pp.15-28.

22. Soysal, Y., 2005. Mathematical modeling and evaluation of microwave drying kinetics of mint (Mentha spicata L.). Journal of Applied Sciences, 5(7), pp.1266-1274.

23. Gaur, S., Shivhare, U.S., Sarkar, B.C. and Ahmed, J., 2007. Thermal chlorophyll degradation kinetics of mint leaves puree. International Journal of Food Properties, 10(4), pp.853-865.

24. Arnon, D.I., 1949. Copper enzymes in isolated chloroplasts. Polyphenoloxidase in Beta vulgaris. Plant Physiology, 24(1), p.1.