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Application of the Response Surface Method in the Analysis of Ohmic Heating Process Performance in Neera

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ABSTRACT: India is the largest producer of coconut. The neera is a very susceptible product tapped from the spadix of coconut. Shelf life of the neera is very low because of bacteria and yeast fermentation. Novel processing method are emerging techniques to increase the shelf life of the product. Is study is focusing of the optimizing the ohmic processing by using response surface methodology. Process temperature (60 to 90 °C), process time (60 to 300 s) and process voltage (10 to 40 V) for ohmic heating of neera. The pH and overall acceptability were fixed as a response. The desirable pH and overall acceptability were attained in voltage 23 V, time 196 s and temperature 62° C of ohmic processing.

Keywords: Novel processing of neera. Coconut sap, shelf life extension.

INTRODUCTION

India is the largest producer of coconut (Area: 21,98,980 hectares, production: 20,736.12 million nuts and productivity: 9,430 nuts/ha in the year of 2020-2021) having the third largest area under coconut and number one in productivity among the member countries of the Asian and Pacific Coconut Community (APCC). Tamil Nadu turns out to be second in coconut production (Area: 4,44,921 hectares, production: 51,282 lakh nuts and productivity: 11,526 nuts/ha in the year of 2020-2021) (Anonymous, 2022) and third in area under coconut cultivation. Coconut sap is also called palm nectar, is a sweet, translucent drink that has been picking up ubiquity due to its high healthful esteem. It is one of the healthiest and non-alcoholic drinks delivered by tapping palmyra palm, coconut palm or different palms. It can be used in making of several produce such as jaggery, sweeteners, concentrated syrup etc. Neera contains 16 kinds of amino acids and various vitamins such as vitamin C, vitamin B complex (vitamin C, B1, B3, B4, B2 and B10 in 116.19, 4.33, 1.88, 0.084, 0.53, and 0.33 µg/ml, respectively) (Asghar *et al*., 2019). It has less calorific value, apart from being sweet and delicious and also functions as a good digestive agent. Neera helps keeps your body hydrated while the supplements in it sustains your body and keeps you feeling vigorous and revived. Coconut sap or neera is being traditionally tapped from coconut in an unorganized manner and consumed largely by rural population. It is reported to be a good digestive, facilitating clear urination and preventing jaundice (Anonymous, 2022).

However, spontaneous fermentation by various microorganisms at ambient storage converts the coconut neera into an alcoholic beverage. Different micro-organisms, such as *Bacillus, Lactobacillus, Micrococcus, Enterobacter, Leuconostoc, Saccharomyces, Candida* and *Pichia* were reported in coconut neera. Generally, neera is preserved using a combination of processing methods such as pasteurization, filtration, chemical or bio-preservatives, clarifying agents, centrifugation and carbonation. However, various technologies did not arrest the growth of micro-organisms in Neera, and it changes the organoleptic qualities. Even at refrigerated temperatures, the microbes maintain their viability and spoil the quality of neera within 3 days; the number of days may vary according to the initial microbial population. Neera is not suitable for consumption when pH decreases to 6. The neera stored in refrigeration condition maintained original condition for 6 hours. But room condition enhanced the fermentation rate (Pandiselvam *et al*., 2021).

Ohmic is similar to high temperature short time (HTST) treatments and function as a conventional heating process of juices with additional benefits of rapid and uniform heating. Ohmic is a rapid and uniform heating technique which leads to inactivation of the microbial load and enzymes activity in a shorter time with a smaller loss of ascorbic acid and strange smell

compared to conventional heating (Machado *et al.,* 2010).

In Icier and Ilicali (2005ab) used an ohmic heating technique to study the relationship between electrical conductivity and temperature. The electrical conductivity of the puree and temperature were shown to be linearly correlated in this study, which dried apricot and peach puree using an ohmic heating method in voltage gradients of 20 to 70 V cm^{-1}. Additionally, it was noted that the electrical conductivity increased with temperature and that the puree boiling happened at the maximum gradient at a temperature of 60°C. However, apricot puree changed temperatures more quickly than peach puree did. Furthermore, at 60°C and high gradients, fluid boiling bubbles appeared, and the electrical conductivity of the ohmic heating was a crucial design factor.

The thermal processes are essential for health of foods. In the present research, the response surface method was used for optimizing the ohmic processing parameters with responses of pH and overall acceptability.

MATERIALS AND METHOD

Collection of samples. Fresh and clear coconut sap (Neera) purchased from Namakkal Kaveri Neera Coconut Producer Company Limited, Namakkal and Vinayaga Coconut Producer Company Limited, Coimbatore. The average pH of the procured neera was 6.5. The collected neera was stored at -18° C for further processing.

Ohmic heating. Laboratory model ohmic heating equipment available at Department of Food Plant Operations, College of Food and Dairy Technology, Chennai was used for the ohmic processing of neera. The system consisted of an acrylic processing chamber (15×5×10.5 cm) covered with SS 304 box. Electrodes: Titanium plate (2×9.5×0.15 cm) having 5 cm gap between them. Variable power supply was obtained using dimmer stat from domestic supply (230 V and 50 Hz). Temperature controller, solenoid valves, timer – 3 nos., thermometer, ammeter and voltmeter were attached with the system to take the readings manually (Perasiriyan *et al.,* 2016).

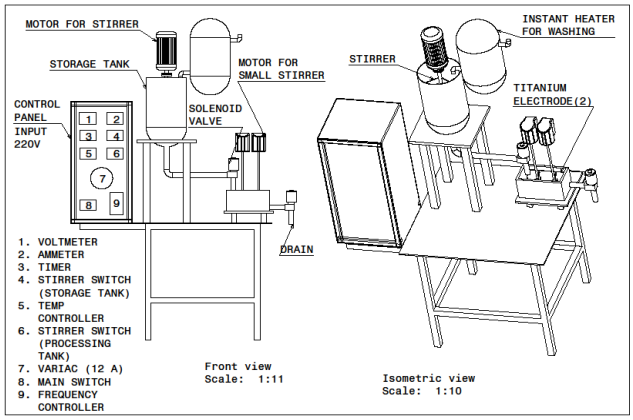

Fig. 1. The line diagram of laboratory ohmic heater.

Experiment design. The effects of voltage gradient, time and temperature (independent variables) on pH and overall acceptability (responses) of the neera were investigated using response surface methodology (RSM). A central composite model was used: voltage gradient (10 to 40 V/cm), time (60 to 300 s) and temperature (60 to 90 ºC). The central composite design was set up for three factors, with three coded levels (- 1, 0, and + 1), as illustrated in Table 1. The significant terms in the model were found by analysis of variance (ANOVA) for the responses (pH and overall acceptability) and validation of the equation was investigated by model ANOVA statistics.

Table 1: Three level factorials with experimental values of response variable.

Treatments	Run	Voltage (V)	Temperature (ºC)	Time (s)	pH	Overall Acceptability
T_1	1	40	60	300	6.933	7.32
T_2	2	40	75	180	7.233	7.13
T_3	3	40	90	300	7.967	6.48
T_4	4	40	60	60	7.1	7.42
T_5	5	40	90	60	7.233	6.67
T_6	6	10	90	60	7.567	6.58
T_7	7	10	90	300	7.6	6.54
T_8	8	25	90	180	7.567	7.25
T_9	9	25	75	180	7.033	7.08
T_{10}	10	25	75	60	7.067	7.12
T_{11}	11	25	75	300	7.133	6.82
T_{12}	12	10	75	180	7.367	6.83
T_{13}	13	10	60	300	7.067	7.17
T_{14}	14	10	60	60	6.91	8.08
T_{15}	15	25	60	180	6.9	8.21

Statistical analysis. The statistical analysis was conducted to investigate the impact of various parameters on each dependent variable. The data were tabulated, and statistical analysis was conducted using IBM SPSS® 20.0 for Windows® software as per Snedecor and Cochran (2004). The analysis of variance (ANOVA) was determined.

RESULT AND DISCUSSION

Effect of OH on pH of neera. The Fig. 2 showed that the effect of voltage, temperature and time on pH of the neera. The pH was not affected on voltage. When temperature increase the pH of the neera also increased on linearly. Highest pH value was attained in 90° C of ohmic processing and with respect to the time of processing pH was increased. The temperature 75° C gave neutral pH of the neera. Darvishi *et al.* (2013) who stated that the pH of the pomegranate juice was increased by temperature.

Effect of OH on overall acceptability of neera. The Fig. 3 showed that the effect of voltage, temperature and time on overall acceptability of the neera. The overall acceptability was affected by temperature, time and voltage. When temperature increases the overall acceptability of the neera also increased up to 75°C then the overall acceptability was decreased. Highest overall acceptability value was attained in 75°C of ohmic processing. The temperature 60°C and 75°C achieved low overall acceptability during sensory evaluation. (Leizerson and Shimoni 2005) studied on the effect of ohmic heating on sensory attributes of orange juice. The sensory parameters deteriorated when temperature was increased.

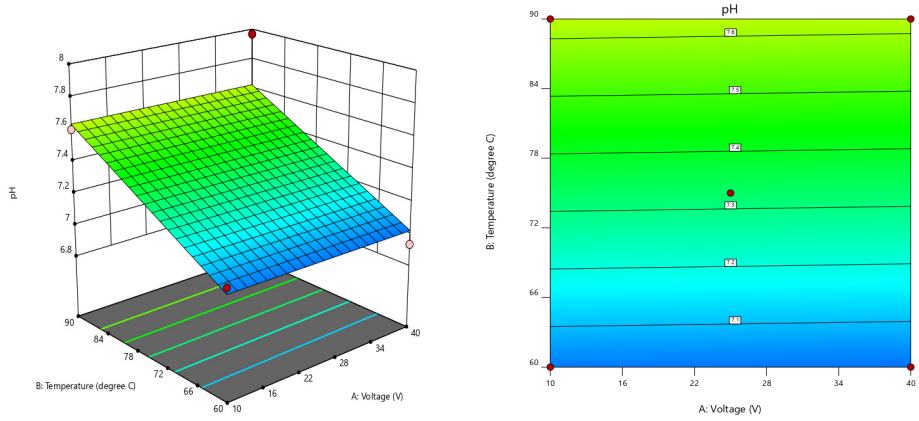

Fig. 2. Effect of ohmic heating (OH) parameters (voltage gradient, time and temperature) on the pH.

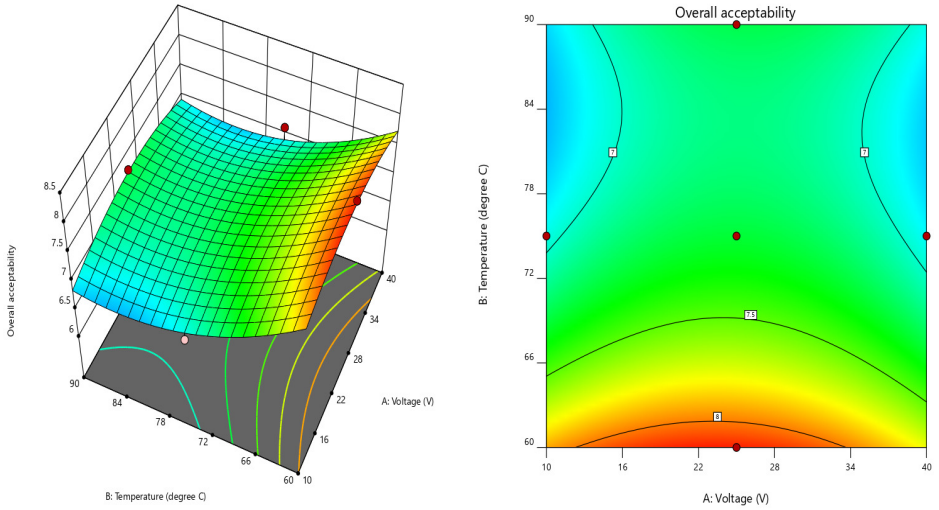

Fig. 3. Effect of ohmic heating (OH) parameters (voltage gradient, time and temperature) on the overall acceptability.

CONCLUSIONS

According to obtained results from the surface response method, values of Lack of fit were not significant for any factor of pH and overall acceptability. Value of R^2 was greater than 0.73. The voltage 23V, time 196s and temperature 62°C was gave maximum overall acceptability and neutral pH during ohmic processing.

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Conflict of Interest. None.

REFERENCES

Anonymous (2022). https://www.coconutboard.gov.in// dated: 27.12.2022

Asghar, M. T., Yusof, Y. A., Mokhtar, M. N., Ya'acob, M. E., Mohd. Ghazali, H., Chang, L. S. and Manaf, Y. N. (2020). Coconut (Cocos nucifera L.) sap as a potential source of sugar: Antioxidant and nutritional properties. *Food Sci. Nutr, 8*(4), 1777-1787.

Darvishi, H., Khostaghaza, M. H. and Najafi, G. (2013). Ohmic heating of pomegranate juice: Electrical conductivity and pH change. *J. Saudi Soc. Agric. Sci*., *12*, 101-108.

Icier, F. and Ilicali, C. (2005a). Temperature dependent electrical conductivities of fruit purees during ohmic heating. *Food Res. Int., 38*(10), 135–1142.

Icier, F. and Ilicali, C. (2005b). The effects of concentration on electrical conductivity of orange juice concentrates during ohmic heating. *Eur. Food Res. Technol., 220,* 406–414.

Leizerson, S. and Shimoni, E. (2005). Effect of ultrahigh-temperature continuous ohmic heating treatment on fresh orange juice. *J. Agric. Food Chem., 53*(9), 3519-3524.

Machado, L. F., Pereira, R. N., Martins, R. C., Teixeira, J. A. and Vicente, A. A. (2010). Moderate electric fields can inactivate Escherichia coli at room temperature. *J Food Eng., 4*, 520–527.

Pandiselvam, R., Manikantan, M. R., Binu, S. M., Ramesh, S. V., Beegum, S., Gopal, M. and Shil, S. (2021). Reaction kinetics of physico-chemical attributes in coconut inflorescence sap during fermentation. *J. Food Sci. Technol., 58*(9), 3589-3597.

Perasiriyan, V., Priya, S., Gowri, A. M., Ramasamy, D. and Sivakumar, T. (2016). Design and Evaluation of Electrical Resistance Unit (Ohmic Heating) for Food Processing. *Int Res J Eng Technol., 3*, 1357-1361.

Snedecor, G. W. and Cochran, W. (1994). G Statistical Methods. New Delhi: Oxford and IBM, Publications, 265-279.

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