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Study on OHMIC Heating System and Its Application for Processing of Selected Fruits and Fruit Products

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ABSTRACT

Ohmic warming is a novel and rotating warm handling innovation wherein food materials are warmed by going electric flow through materials. Ohmic warming has extraordinary potential for accomplishing quick and uniform warming in nourishments, giving microbiologically protected and great food sources. Ohmic warming presents a wide scope of potential applications including purification, cleansing, aseptic handling, cooking, defrosting, whitening, vanishing, extraction, aging, and in the military field or long-term space missions. This survey talks about the short history, fundamental standard, some interaction boundaries, pertinent food items, expected business applications and current modern status of ohmic warming in food industry all through the world. The survey additionally features the degree and work done on ohmic warming in India. The erosion issues in terminals and heterogeneous warmth age rate and appropriation are fascinating territory for additional examination. Ohmic warming is a decent tantamount with the other ideal innovations like microwave warming, radio-recurrence warming and acceptance warming. More and escalated examinations are needed to survey execution and to decrease the general expense of ohmic warming for feasibility of business use of this innovation additionally in non-industrial nations like India

Keywords: *Ohmic, Heating, Fruits*

INTRODUCTION

The world's second largest producer of fruits and vegetables. Total fruit production in India was 86.60 million metric tonnes under the cultivation area of 6.11 million hectares during 2014-15 according to NHB, 2017, while fruit exports were registered at Rs. 3524 crore (2015-16) . Due to the growth of the cold chain facility and quality assurance measure, demand for horticultural products is growing, but the share of the global market for I niacin is only 1 percent. L udhiana (2015), a recent study conducted by CIPHET, shows the overall net loss of fruits and fruits

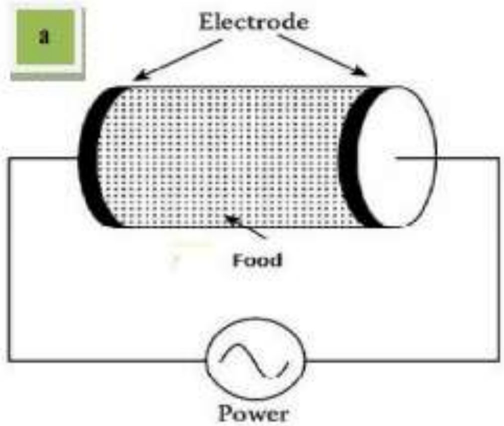

Fig. 1.1 (a) Outline sketch of ohmic heating

Fig. 1.1 (b) Two unit parts of an ohmic heater assembly (S tirling, 1987)

4.58-15.88 percent of the value of Rs. 40811 crore was vegetables. Another research, however, suggests greater losses (25-30 percent), estimated at Rs . Per annum, one trillion (The Hindu, March 10, 2016). The mega food park, integrated cold chain, value addition, preservation and modern infrastructure schemes have already been 1 cold chain, value addition, preservation and modern infrastructure schemes have already been started by the Government of India to reduce these losses. Pre-conditioning, pre-cooling, ripening, waxing, retail wrapping, fruit and vegetable marking services were removed from the t axe service in the 2015-16 Budget (PIB, 2016). In nature, fruits are perishable and vulnerable to microbial attack. Crop and fruit products have long been thermally processed for the manufacture of blanched, pasteurized, sterilized, dehydrated, dried and concentrated products. Microbiological protection is assured by traditional thermal processing, but the nutritional and sensory characteristics of developed products can change. So, day by day, the market for alternative technology is growing. Consumers prefer food items that are minimally processed and fresh. The widely used techniques are high pressure processing, microwave heating, radio-frequency heating, and thermo-sanitation, oscillating magnetic field, high pulse electric field and holmic heating. These approaches are used as novel techniques for food production.

OBJECTIVES

1. To design and develop lab scale ohmic heating assemblies

2. Ohmic heating assisted product development from fruits.

WHAT IS OHMIC HEATING?

Ohmic heating is a novel food processing method in which an alternating current passes through food products to heat them (Fig. 1.1a and b). It is also known as electrical heating, electrical conductive heating, direct heating, heating of electrical resistance and heating of Joule (Kaur and Singh, 2016). This technique is based on the James Prescott J oule (184 1) prin ciple of juille impact. There is heat generation when an alternating current is passed through some conductive material due to I 2R losses within it (Stirling, 1987). The movement of ions takes place as electricity is transmitted via food materials. Moving ions collide with molecules and transfer their kinetic energy to molecules, resulting in the food product heating (Lyng, 2014). Ohmic heating may be accomplished either by direct current (DC) or alternating current (AC), but due to the simple availability of AC's supply and incidence of electrode polarisation in the DC system in most food applications alternating current is u sed. H, however, can be used to supply AC power with various frequencies different from the local power supply. The ohmic heating rate is directly proportional to the electric field intensity and electric conductivity of the square (Sastry and Palaniappan, 1992). Electrical conductivity (Fryer and Li, 1993 and Sarang et al. 2008), which depends on temperature, frequency, and composition of the substance, is the most significant parameter in ohmic heating; it can be increased by adding ionic compounds (salt and acid) and decreased by adding nonpolar components such as emulsified lipids. Material 2 must be able to conduct an electrical current for processing ohmic heating. In addition, the electrical conductivity of liquid food increases with increasing temperature, although it also depends on the strength of the electric field in the case of solid food.

Food is placed in between two electrodes to conduct ohmic heating and current is transferred. In contrast with traditional heating, ohmic heating, due to improved nutrient retention and oraganoleptic properties, has been found to be a better technique for thermal processing of food. A unique aspect of this technique is rapid and uniform heating, due to internal heat generation during ohmic heating (De Alwis and Fryer, 1990), volumetric heating takes place when heat is transferred in traditional heating from outside to inside by conduction, convection and radiation ion. In addition, the upper temperature limit for ohmic heating exceeds traditional processing by much. Another benefit of this technique is online monitoring of the heating rate by voltage variance. An additional advantage of ohmic heating technology is the energy efficiency and diversity of designs. The efficacy of this inactivation process for microorganisms depends primarily on the thermal effect, but the non-thermal impact of the electric field is also recorded.

APPLICATION OF OHMIC HEATING IN FOOD INDUSTRY

Researchers began researching the possible applications of ohmic heating in food processing in the late 1980s, with the exception of a few examples of electrical pasteurization of milk and eggs in the early 1990s. As stated by Varghese Varghese et al, sterilization, heat ting of liquid foods containing large particulates and heat sensitive liquids, aseptic processing of space food and

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military ration, ohmic thawing, inactivation of spores and enzymes, blanching and extraction are seen as a major application of ohmic heat ohmic heat g. 2012. (2012). Several researchers have already conducted numerous studies to evaluate the effect of ohmic heating on different food product characteristics, such as electrical conductivity of food materials, degradation of ascorbic acid, kinetics of c olour degradation, degradation of total phenolic content, pH transition, removal of moisture, frying, protein coagulation in meat, ohmic cooking of food products and peeling .

PROCESSING OF FRUITS AND FRUIT PRODUCTS BY OHMIC HEATING

Therefore, thermal processing alters the nutritional content of fruit and fruit products; in order to manufacture better quality end products, it needs alternative processing. Ohmic heating is economically feasible since it can be applied to the majority of industrial processed goods (Castro et a l ., 2003). Processing by ohmic heating of fruit and fruit products is very effective as fruits also have natural acidity. In most cases, the processing temperature is kept below 100 °C, the time and temperature range depending on the pH of the fruit and fruit pro ducts. In the literature, the effect of ohmic heating on different attributes of fruit and fruit products is stated.

Ohmic orange juice heating was carried out by a researcher to evaluate the following parameters: viscosity and EC of orange juice, position of the particle e concentration in orange juice in the overall EC of the two-phase system during ohmic heating, inactivation of Bacillus subtilis spores, kinetics of degradation of ascorbic acid, consistency comparison of traditional and ohmic pasteurized juice. To access EC, Peach puree was o hmic heated . Apple processing by ohmic heating has been documented to estimate viscosity, EC, juice yield and hot-air drying rate, pectin methyl esterase inactivation kinetics and degradation of ascorbic acid. Darvishi et al., 2013, and a few others have been working on ohmic pomegranate te juice heating to observe some of the parameters described above. Rheological analysis of quince nectar, degradation of anthocyanin during ohmic heating recorded in sour cherries. Strawberries have also been treated with ohmic heating to evaluate EC, ascorbic acid degradation, anthocyanin degradation and strawberry microstructure. Grape s and guava ha v e are already undergoing ohmic heating processing.

The primary specifications for ohmic heating devices for food processing are the p air of electrodes, a container for the food to be processed and an alternating power supply. There is a lot left in the design of heating assembly parts. There is a broader variety of developments in the field of ohmic heating systems for both equipment designers and product developers (Sastry, 2014). 4 In addition, several researchers have used f or ohmic heating of food materials in various forms of o-hmic heaters. There are many variations in size, form, treatment chamber and electrode construction material used, working power, cell constant and el ectrode gap etc. in addition to the basic concept of ohmic heating. A n insulated material or conducting material lined by an insulating film, F or the creation of an ohmic heating assembly, is used as a construction material for the treatment chamber. The materials used for the construction of ohmic heating assemblies are nsulated glass bottle, Teflon, Pyrex glass tube, Acryl plastic vessel and Stainless steel inner lined with Teflon coating. Commonly used designs are R ectangular cross section and cylindrical tubes. For the development of e-lectrodes, different types of materials such as stainless steel, platinum, titanium and p latinum coated titanium may be used. The electrode gap is chosen based on the conductivity of the food material and the operating conditions needed (Sastry, 2014). Thus, the specification of assemblies was finalised in the present study according to processing requirements i. e. Processing of fruit as a whole or processing of fruit and fruit products as juice, pulp, purée or semi-liquid conditions. To compare the conservation of nutrients and sensory properties with traditional blanching, the study of ohmic blanching of atonal and strawberry was conducted. In order to encourage the cultivation of citrus fruits, the National Horticulture Board has declared South West Haryana a citrus region. There will be tremendous fruit production in this region in the future. Due to lifestyle and food safety issues, demand for RTS and packed juices is growing on the market. So, by using this method, it was expected that a more nutritious and microbiologically safe drink could be prepared. An alternative meth od of pulp processing is also needed by commercial production of peach based products. In addition, c onsumer demand is minimally formulated free preservative with minimum addition of additives, so this technology can prove its effectiveness to meet these requirements.

DESIGN OF OHMIC HEATER

A pair of electrodes, a container for food processing and an alternating power supply is the fundamental specifications for ohmic heating equipment for food processing. It is possible to run the process either in batch mode or continuously. A horizontal cylinder during a continuous process is the most common ohmic heater used for a batch process; depending on the manufacturer, various types of designs may be used. The various forms of design used in continuous ohmic heaters are a basic tube with pairs of opposing electrodes placed on the tube walls opposite each other, coaxial tubes acting as electrodes with the food flowing through them, or a vertical tube with the electrodes embodied at regular intervals.

There are two types of configuration: cross-field when the electric field is perpendicular to the flow of food, and field when the electric field is parallel to the flow of food. In cross-field configuration, the electric field strength remains constant while, in the case of in-field configuration, it increases because of this, as food approaches the outlet, the field strength encountered by the commodity often increases. A collection of electrodes are used to prevent problems of this kind. In general, the designs for ohmic heaters are tailored for individual applications. In designing parts of ohmic heating assemblies, a lot is left. There is a broader variety of developments in the field of ohmic heating systems for both equipment designers and product developers. High-voltage, low-current devices in which the electric field configuration is typically used in ohmic heaters in line with the flow or low-voltage, high-current devices (across the flow). By changing its operating state, an ohmic heater can be used for any object, while a food material can be ohmically processed in any design by changing its composition and behaviour (Sastry, 2014).

APPLICATION OF OHMIC HEATING IN FRUIT PRODUCTS

Therefore, thermal processing alters the nutritional content of fruit and fruit products; in order to manufacture better quality end products, it needs alternative processing. Ohmic heating is economically feasible since it can be applied to the majority of industrial processed goods. It is very effective to process fruits and fruit products by ohmic heating as fruits also have natural acidity. The manufacturing temperature was, in most cases, kept below 100 °C. The time and temperature range is dependent on the pH of the fruit and fruit products. In the literature, the effect of ohmic heating on different attributes of fruit and fruit products is stated. Many scientists conducted ohmic heating of orange juice to test the following parameters:

Orange juice viscosity and EC, the effect of particle concentration in orange juices during ohmic heating on the overall EC of a two-phase system for B . Inactivation of subtitles spores, ascorbic acid degradation kinetics and traditional and ohmic pasteurized juice consistency c comparison. In order to estimate viscosity, EC, juice yield and hot-air drying rate, inactivation kinetics of pectin methyl esterase and ascorbic acid degradation, apple processing by ohmic heating has been documented and few others have worked on ohmic pomegranate juice heating to observe some of the above parameters. Rheological analysis of quince nectar, degradation of anthocyanin in sour cherries during ohmic heating Strawberries have also been confirmed to have been treated with ohmic heating to determine EC, degradation of ascorbic acid, degradation of anthocyanin and microstructure of strawberries Grapes and guava Grapes and guava have already been processed by ohmic heating.

In order to research the impact of material used in ohmic heating on milk fouling, different forms of electrodes such as stainless steel, tin and graphite electrodes were used. Findings revealed the main effect of electrical phenomena and corrosion as the stainless steel electrodes were the worst whereas the graphite electrodes were the best where no fouling was observed. The hydrodynamic activity of milk was observed in a flat ohmic cell by Ayadi et al ., (2005). Hydrodynamic disturbance can occur during continuous ohmic heating, resulting in thermal and electrical disturbance and areas generated. In the produced areas where the volume of deposit was greater and the temperature was lowest with non-18 uniform velocity, the fouling was greater.

CONCLUSIONS

as a whole where orange and bael were used as pulp in the case of peach and juice was taken as a whole. Using various components such as voltage variac, insulation transformer, temperature sensor and controller, digital voltmeter, digital ammeter, frequency metre, temperature indicator and treatment chamber/ohmic heating asse mbly, Ohmic Heating System em was first developed. Following successive trials, the Design Chamber was finalized. Porcelain tray and rectangular electrodes were used for the first experiment. Owing to excessive heat loss from electrodes, this model was not further used as only 1/10th portion of the electrode was immersed in the sample. CPVC tubing was used for the second experiment. As reflected from the score of treated juice samples, especially the unpleasant aroma and taste, it was also discarded due to degradation of pipe materials at higher temperatures. Long neck glass beakers were used for the processing of w-hole fruit and juices in the next attempt.

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