EFFECT OF ULTRASOUND ON QUALITY PARAMETERS AND MICROBIAL LOAD OF MUSK MELON JUICE

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ABSTRACT

Over the past eight years, there has been a notable surge in the global demand for melon fruit juices. Consumers have been increasingly drawn to this particular beverage due to its appealing taste and noteworthy nutritional attributes. To meet this growing demand and address the imperative of prolonging the shelf life of melon juice while preserving its inherent nutritional qualities, a strategic approach to preservation is requisite. The conventional technique used for fruit juice preservation involved high-temperature processing. However, this method comes with inherent disadvantages. Increase in temperatures can induce the development of undesirable off-flavors, contribute to the degradation of the juice's color, and result in the depletion of vital vitamins and aromatic compounds. Recognizing these limitations, it becomes paramount to explore alternative preservation methods, notably non-thermal treatments such as Ultrasound Treatment. Ultrasound treatment presents a compelling prospect for conserving and enhancing the juice's intrinsic quality parameters. These parameters improve essential elements such as color, flavor, and odor, which contribute significantly to the sensory appeal of the product. It is imperative that these attributes remain unaltered to ensure consumer satisfaction and product acceptance.

Keyword : - *Ultrasound Treatment, Non thermal treatment, quality parameters, microbial load reduction,*

1. Introduction

Musk melon juice is a warm seasonal fruit old-world cucurbit species which belongs to family Cucurbitaceous. The development of demand in muskmelon increases over half decades currently there is no product in the market with melon as a major ingredient. For the purpose of preserving fruit juices, thermal pasteurization and sterilization are often employed methods. The underlying idea suggests that inactivating enzymes and bacteria will increase shelf life but the heat-sensitive nutrients, bioactive components, colour and fresh flavor are unfortunately degraded by the intensities of treatment, time, and process temperatures. The food industry was compelled to look at alternative technologies for preservation as a result of this constraint and rising customer awareness of nutrition and health. Since the past ten years, non-thermal technologies have attracted a lot of research attention. One of the fast developing non-thermal methods for improving quality and ensuring safety, particularly with food that has heat-sensitive nutritional, sensory, and functional qualities, is ultrasound. Consumers are becoming more attracted to the reviving and nutrient-rich qualities of this delicious beverage, which has seen a significant rise in demand for melon fruit juices globally in recent years. The demand for efficient preservation techniques that can increase the shelf life of melon juices while maintaining their nutritional value and inherent quality standards rises along with their popularity. Although conventional high-temperature processing methods are frequently used to preserve fruit juice, it has been discovered that they have drawbacks, such as the development of off flavors and the deterioration of color, vitamins, and aromatic compounds. Researchers have focused on creative non-thermal preservation techniques in order to address these issues and satisfy the growing demand for premium melon fruit juices, with ultrasound treatment emerging as a promising solution. The aim of this study is to look into ultrasound treatment's potential as a modern, non-thermal method of preserving melon fruit juices. By utilizing the power of cavitation, this technique holds the promise of improving the nutritional value of the juices as well as preserving their sensory qualities, such as color, flavor, and odor, in addition to extending their shelf life. Non-thermal treatments are used

because they can lessen the negative effects of high-temperature processing, which can result in the loss of vital nutrients and a decline in organic qualities.

1.1 Ultrasound Treatment -1

The use of ultrasound treatment as a non-thermal preservation technique for melon fruit juices is an interesting approach to extend their shelf life while retaining their nutritional properties and natural quality parameters. In fact, high-temperature processing can cause the color, vitamins, and aromatic compounds to degrade, giving the juice an off flavor. Applying high-frequency sound waves to the liquid during ultrasound treatment causes cavitation bubbles to collapse and produce concentrated high temperatures and pressures in the affected area. The release of bioactive compounds from the fruit, which can increase the juice's nutritional value, is one of the many effects this phenomenon may have on fruit juice. The microbial load in the processed melon juices can be decreased by applying ultrasound treatment. Cavitation and the subsequent high-pressure conditions can harm microbial cells, which makes them inactive. The melon juice's shelf life can be increased as a result of the reduction in the growth of spoilage microorganisms. The risk of negative effects on the sensory characteristics of the juice, such as flavour and odor, which might be negatively influenced by standard high-temperature pasteurization methods, is also minimized by ultrasound treatment because it is a non-thermal technique. The ultrasound parameters, treatment time, and intensity must be optimized, as with any preservation technique, in order to achieve the desired preservation effects without affecting the melon juice in an unfavourable way. The commercial feasibility of widespread application and consumer acceptance of melon juices treated with ultrasound should also be taken into account.

Overall, ultrasound treatment holds promise as a non-thermal method of preserving melon fruit juices, and further study may yield insightful information about how it might be used in the food industry to satisfy the rising demand for this product.

1.2 Advantages of ultrasound treatment

• Nutritional retention: In order to prevent vitamins, antioxidants, and phytochemicals from being destroyed during high-temperature processing, ultrasound treatment is used to preserve the nutritional value of melon fruit juices.
• Extended Shelf Life: The processed melon juices' shelf life is extended thanks to the ultrasound treatment's reduction of microbial load, which also reduces food waste and improves product availability.
• Enhancement of Flavour and Aroma: Unlike conventional high-temperature processing, ultrasound treatment does not result in the development of off Flavors or changes in aroma, maintaining the natural flavour and aroma of the melon juice.
• Improved Colour Retention: Because ultrasound treatment is non-thermal, the melon juice's colour doesn't deteriorate, keeping it attractive and natural-looking.

1.3 Applications of ultrasound

• Reduced energy consumption: Ultrasound can be used to accelerate a variety of food processing operations.
• Ultrasound can help to improve the quality of food products
• It can be used to shorten the processing time.
• Ultrasound can be used to inactivate microorganisms and enzymes,
• Ultrasound is a sustainable technology that does not cause any harmful emissions
• The industrial-scale production of melon fruit juices can incorporate ultrasound treatment, allowing producers to enhance the shelf life of their products without affecting quality.

2. OBJETIVES AND METHODOLOGY

The three main objectives are Optimization study of melon juice using ultrasound treatment, Characterisation study of the ultrasonically treated melon juice and Shelf life study of ultrasonically treated melon juice.

1.Optimization study of melon juice using ultrasound treatment: The main goal of this experiment is to use a traditional extraction technique to obtain musk melon juice. In order to remove any sediments, the obtained juice will then go through a filtration process, producing pure, crystal-clear fruit juice. The target Brix level for the fruit juice is set at 24 to ensure product consistency and quality. After the extraction and filtration processes were successful, the study's goal is to analyze the effects of ultrasound . A sonicator with a fixed frequency of 20 kHz will be used for this treatment. With breaks of 5,10,15 minutes, the ultrasound treatment will be applied gradually. In

addition, various amplitudes of 60%, 70%, and 80% will be used.

2.Characterisation study of the ultrasonically treated melon juice: The quality parameters like colour, acidity, taste, brix, aroma are analysed.in this objective the colour of the juice analysed in colorimeter after treating the sample in ultrasound at 3 different power levels. The colour parameters analysed in colori meter are L* (Lightness): The L* component represents the lightness of a colour. It ranges from 0 (black) to 100 (white), a* (Red - Green Axis): The a* component represents the position on the green-red axis, b* (Yellow - Blue Axis): The b* component represents the position on the blue-yellow axis. Positive values represent the yellow end, and negative values represent the blue end. The ph of the juice is analysed by digital ph meter, the sugar is analysed by brix meter. These analysed values are noted and feed in Response surface Methodology software to create 3d model surface to analyse the end result.

3.Shelf life study of ultrasonically treated melon juice: Total microbial load is analyzed by total plate count, to determine the shelf of the ultrasonic treated melon juice and also to determine the effect of ultrasound on the microbes either decreases or increases. For total plate count pour plate technique method is used to analyze the microbial load of taken sample which are treated with ultrasound in different frequency and different time range. Total plate count is a technique in which the microbes are allowed to grow in the nutrient agar as a formation of colony to identify its population by counting the colony using colony counter, the counted number is substituted in the log formula to identify its population so we can determine the harmfulness, bacterial nature and shelf life of the product. The RSM software is very vital to reduce the trail for total plate count. In this software we will able to find the optimum frequency which affect the microbes in treatment. The serial dilution is carried to dilute the population of microbes in the sample because the high population in concentrated sample will form a un countable colony in the media which is hard to calculate merely impossible. There is also a high chances of error while calculation without serial dilution so it is very vital process in this technique. The pour plate method is a common microbiological method for calculating the total plate count (TPC), which evaluates the total microbial load, in a sample. In this procedure, a known volume of the sample is poured into a Petri dish along with a sterile agar medium. After solidification, the plate is kept at the proper temperature for an incubation period to promote microbial growth. The microbes in the sample incorporate themselves in the agar and form colonies that are easily visible. The number of colonies that form on the plate corresponds to the number of microorganisms in the initial sample. This technique is useful for checking samples of food, water, and the environment for contamination and is essential for quality control and safety assurance in a variety ofindustries.

2.1 Materials and Method

JUICE PREPARATION: Musk melon is brought from market and weighed it clean the fruit using disinfectant water and peel the fruit using peeler. Also remove the waste and pulp from the fruit then weigh them separately. The readings are very useful for the determination of TSS, standardize the brix value and finally to calculate the economic efficiency of the final product. The pulp is extracted using fruit crusher and check for TSS and dilute the pulp using some portable water and filter the pulp to get crystal clear juice. The obtained crystal clear juice is used for the treatment and developed in to a final product and analysing the various attributes of the fruit juice.

figure 1 : Extraction of musk melon juice

PRE TREATMENT: Sugar concentration in which the normal brix present in the muskmelon juice after extraction is 4 brix which is natural sugar present in it. At this brix value it will not taste as much sweeter so we added additional sugar to increase the brix value. The normal brix for fruit juice like musk melons are 20-24 brix. This is optimum brix for good sweetness. The sugar was added to juice to adjusting the soluble solid content to 24°Brix. It also acts as a preservative by increased sugar concentration some microbes will inactive because sugar is a natural

preservative.

FREEZING PROCESS: The juice was stored at -18 degrees Celsius prior to processing. The freezing process is important before processing. Freezing the juice prior to treatment will make the microbes and enzymes to in active, which is an additional benefit to the treatment and also increase the efficiency of the process. The instant freezing after the juice extraction is very vital to avoid cross contamination in the fruit juice. by means of freezing the juice we can have one added advantage the ultrasound treatment may carry out later because this freezing itself is a preservation technique it can improve the process flow of the treatment.

CHILLING PROCESS: During the treatment process the freeze juice is cool down to 4 degrees Celsius before prior to treatment. Not only the freezed juice also the freshly extracted juice temperature should be maintaining at 4 degrees Celsius. The temperature of the juice will elevate during the process by means of continuous cycle of compression and rarefaction of sound waves into the juice will induce the heat in the juice which may produce thermal effect on the food products. To avoid thermal effect on food chilling is a good way to prevent heat transfer. Here the temperature will improve but it will not exceed the 10 degrees Celsi

2.2 Ultrasound Treatment of Fruit Juice by Ultrasound Probe Type

The following steps are often involved in the ultrasonic treatment procedure for fruit juice:

1. The fruit juice is poured into an appropriate tank or container.
2. The processor or ultrasonic probe is submerged in the juice.
3. The juice is exposed to ultrasonic waves for a predetermined amount of time while being stirred regularly to achieve uniform treatment.
4. ensure the intended benefits are realized without overheating, the treatment is monitore

2.3 Working of Ultrasound Equipment

An apparatus that changes one form of energy into another is called a transducer.

- The transducers used in ultrasonic applications are made to transform mechanical or electrical energy into high-frequency sound.
- Mechanical and electroacoustic transducers are the two primary categories.
- Mechanical transducers produce ultrasound by forcing a liquid or gas through a siren, rotor, turbine, or whistle.
- To create piezoelectric or magnetostrictive transducers, electromechanical transducers are based on the inherent electrostrictive phenomenon in specific materials.
- Through the utilisation of the piezoelectric effect, in which specific materials change dimension when an electrical charge is supplied to them, piezoelectric transducers transform alternating electrical energy directly into mechanical energy.
- The ultrasonic generator delivers electrical energy to the transducer at the ultrasonic frequency.
- The piezoelectric element(s) of the transducer vibrate when this electrical energy is applied to them.

2.4 Methods of Ultrasound

The use of ultra-sound at low temperatures is known as ultrasonication (US) It can therefore be utilised for products that are sensitive to heat. However, stable enzymes and/or bacteria that can take a lot of energy to inactivate call for extended treatment times. Depending on the ultrasound strength and time of application, there may be a rise in temperature during ultrasound application; this needs to be controlled to optimise the process. Thermosonication (TS) combines the use of heat and ultrasound. The product is concurrently exposed to mild heat and ultrasonic waves. Compared to using just heat, this technique has a stronger impact on the inactivation of microorganisms. When using thermosonication for pasteurisation or sterilisation, shorter processing periods and lower process temperatures are needed to attain the same lethality values. Manosonication (MS) is a combination technique that use both pressure and ultrasound. By mixing ultrasound with moderate pressures and low temperatures, manosonication offers to inactivate enzymes and/or bacteria. At the same temperature, its inactivation effectiveness is greater than that of ultrasonography alone. Manothermosonication (MTS) is a technique that combines pressure, heat, and ultrasound. Compared to thermal treatments at the same temperatures, MTS treatments inactivate a number of enzymes at lower temperatures and/or faster times. The media's cavitation or bubble implosion is maximised by

the applied temperature and pressure, which raises the level of inactivation. Mantheromonication can inactivate microorganisms with exceptional thermotolerance. Additionally, some thermoresistant enzymes from Pseudomonas, including heat-labile lipases and proteases as well as peroxidases, polyphenoloxidases, and lipoxygenases, can be inactivated by manothermosonication.

3. PROPOSED WORK MODULES AND ANALYSIS

Experimental Design and Parameter Optimization is done for optimizing intensiy, frequency ,amplitude
Ultrasound Intensity: An important factor will be the ultrasound waves' intensity. It describes the amount of power or energy delivered per square inch of the sample and can affect how effective is the treatment

Frequency: Throughout the ultrasound treatment, a fixed frequency of 20 kHz will be kept. This parameter is significant because it establishes how many oscillations or waves are generated each second.

Treatment Duration: Another important factor is how long the ultrasound treatment is administered for. The duration of the exposure will be measured in this study at intervals of 5, 10, and 15 minutes to see how it affects the juice.

Amplitude : Different amplitudes will be tested, specifically 60%, 70%, and 80%. Amplitude, which describes the degree of particle movement or displacement brought about by ultrasound waves in a medium, can have an impact on the treatment's intensity.

To assess their effect on the melon fruit juice, these variables will be systematically changed. Physical characteristics like color, pH level, and Brix (a measurement of sugar content) will also be carefully examined. The goal of the study is to identify the ideal settings for maintaining and improving the quality of melon fruit juice while retaining its essential characteristics by examining these parameters under various ultrasound treatment conditions

3.1 Microbial Analysis and Safety Assessment

Collect samples for microbial analysis to evaluate the effectiveness of ultrasound treatment in reducing microbial load. Also analyse the microbial load in the raw sample non treated sample to find the microbial load difference. Perform microbial tests to quantify the microbial populations in treated and untreated melon juices, for microbial test pour plate methods is used. The plate is maintained at the proper temperature for an incubation period after solidification to promote microbial growth. The sample's microbes integrate with the agar to form colonies that are easy to see.

3.2 RSM Software

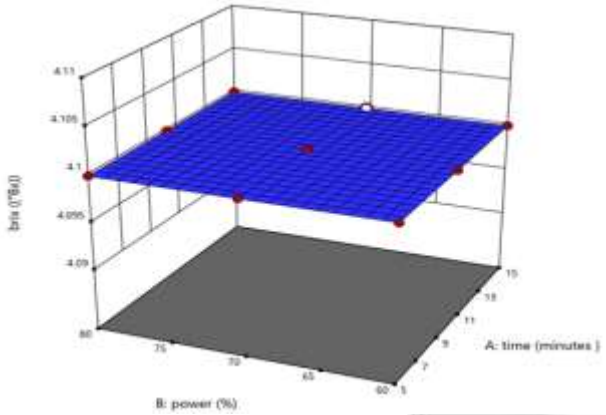
Response surface methodology(RSM) is a software which process the numerical values to find the optimum values and regions or zones also to find the data which are away from our experiment. It is used to reduce the number of trails in experiment by interpreting the data we feed to it by providing a 3D surface modelling. We carry over the RSM before starting the experiment to avoid trails and unwanted experiments. The fact that a lot of data may be gathered from a small number of experiments is one of the main benefits of RSM. The primary impacts of factors and their interaction on the answer can be studied by using models and graphical representations. It finds the factor levels that provide the best reaction and the best circumstances brought about by many responses. A face-centered central composite design (CCD) with three central points was used to investigate the sonication conditions. The processing time was increased from 5 to 15 minutes, and the power intensity was changed from 60 to 70%. The following were the dependent variables: phenolic compound reduction, color, acidity, and brix

3.3 Analysis of physical Parameter

BRIX - There is no change in brix value after the treatment which can be observed from the figure 2

PH - The ph value is increasing as shown in the figure as the power and time of treatment increases the acidity decreases.The pH is analysed by ph meter.The decrease in acidity helps in retention of natural flavours.

OBSERVATION - Raw sample value 6.0, Treated sample value 6.4



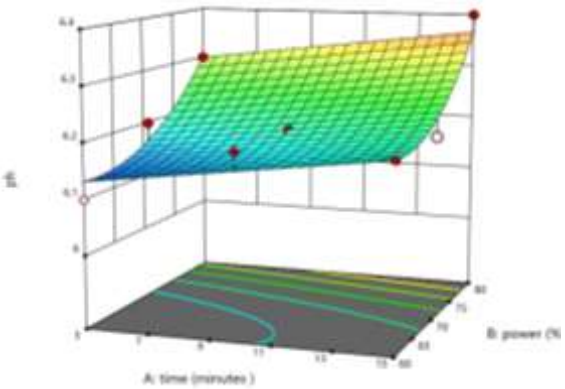
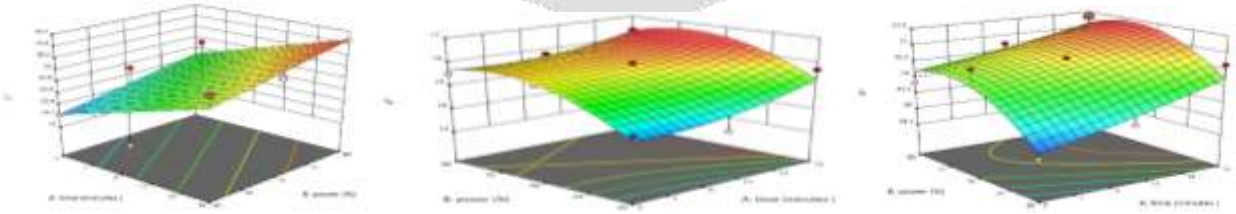


chart 1: brix chart 2: pH

COLOUR – The colour of the musk melon juice is analysed by calorimeter for each sample and L*, a*, b* is calculated by which colour is determined

5 mins	L*	a*	b*
60%	35.22	14.38	34.75
70%	35.73	15.65	36.73
80%	35.52	15.52	35.83
10 mis	L*	a*	b*
60%	35.04	13.79	35.25
70%	35.84	15.95	36.73
80%	35.88	15.82	36.74
15 mins	L*	a*	b*
60%	36.21	15.69	36.65
70%	36.12	16.16	36.7
80%	36.46	16.4	37.34

Table 1: The above table are the values of colour parameters after the ultra sound treatment.



L* a* b*

chart 3:colour parameters

3.4 Overall analysis

		Raw sample	5 mins treatment	10 mins treatment	15 mins treatment	Range in change	conclusion
ph		**6.0**	**6.1**	**6.3**	**6.4**	**0.4**	**Ph increases so which implies these is decrease in acidity of juice**
brix		**24**	**24.1**	**24**	**24.2**	**24**	**Brix value is almost constant**
colour	**L***	**35.03**	**35.52**	**35.88**	**36.46**	**increases**	**The change in colour implies that the red and yellow intensity increase shows the orange colour intensity also increases.**
	a*	**14.21**	**15.52**	**15.82**	**16.40**	**increases**	
	b*	**34.98**	**35.83**	**36.74**	**37.34**	**increases**	
Cloud stability		**poor**	**medium**	**medium**	**high**	**good**	**The cloud stability of fruit juice is improved due to ultrasound treatment.**
homogeneity		**poor**	**high**	**high**	**Very high**	**Highly satisfied**	**The homogeneity of fruit sample also improved in ultrasound treatment by breaking the molecules due to cavitation.**
Microbial load at 10		**768 colony**	**278 colony**	**171 colony**	**44 colony**	**720 colony**	**The decrease in colony count at higher time frame implies that there is a definite reduction of microbial load in the sample.**

table 2: overall analysis

4. CONCLUSIONS

The juice remained completely homogeneous during 2- 3 weeks of refrigerated storage after the processing conditions by means of ultrasound which break the larger molecules and spread them evenly along the product by sound waves.The sonication caused some improvement in colour stability, this technology proved to be suitable for melon juice processing The acidity decreases implies the product stability.The colour of the melon juice is orange, carotenoids present in the melon juice is responsible for this ultrasound induce the carotenoids and enhance the colour Improvement of cloud stability by ultrasound treatment because it deactivate the enzymes (PME) pectin

methylesterase which is responsible for cloud formation. Microbial destruction in melon juice is happen with the help of cavitation procees caused by ultrasound. The figures on the below are the overall analysis result From the figure 6 we can conclude that as the power and time is increased ,the quality of physical characteristics also increased . The colour is increasing on increasing the power and time. There is increase in ph of juice which is a good sign because when acidity is decreased there will be no retention of natural flavours, there will be no need additional flavours. The a* component represents the position on the green-red axis. Positive values represent the red end, and negative values represent the green end. The red end has been increased when the sample is treated with higher power% with higher time frame.

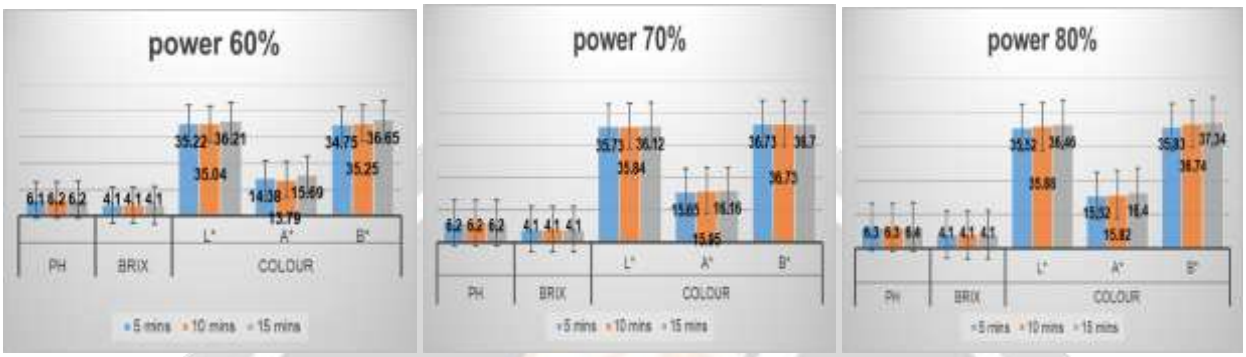


chart 4 : overall result

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6. REFERENCES

[1]. Thatyane Vidal Fonteles , Mayra Garcia Maia Costa and Ana Laura Tibério de Jesus ”Power ultrasound processing of cantaloupe melon juice: Effects on quality parameters”Journal of Food Research International Volume 48, Issue 1, August 2012,

Thatyane Vidal Fonteles (2012) conducted a study to explore the potential of ultrasound treatment in preserving cantaloupe muskmelon juice. The research focused on investigating the effects of ultrasound at a frequency of 19 kHz on the inactivation of specific enzymes, including peroxidase (POD) and polyphenol oxidase (PPO). Additionally, the study examined the impact of sonication on ascorbate peroxidase (APx) enzyme activity. The results of the study were promising. It was observed that the application of ultrasound at a power intensity of 376 W.cm–2 for 10 minutes led to the complete inactivation of APx. This suggests that ultrasound treatment effectively inhibited enzymatic reactions, potentially extending the shelf life of the melon juice by reducing enzymatic degradation. One notable advantage of ultrasound treatment was its non-thermal nature, which meant that no

significant colour degradation occurred in the melon juice. Furthermore, the study analysed the cloud stability of the sonicated melon juice. Cloud stability refers to the ability of the juice to maintain its suspended particles or cloudiness over time. The results indicated that ultrasound treatment did not negatively impact cloud stability, implying that the suspended particles remained adequately stable during the preservation process.

[2]. Adekunte, A. O., Tiwari, B. K., Cullen, P. J., Scannell, A. G. M., & O'Donnell, C. P. (2010). Effect of sonication on colour, ascorbic acid and yeast inactivation in tomato juice. Food Chemistry, 122, 500–507

The study conducted by Adekunte et al. (2010) focused on the impact of sonication on various quality parameters of tomato juice. The researchers investigated the effect of ultrasound treatment on color, ascorbic acid content, and yeast inactivation.
In the experiment, tomato juice was subjected to sonication, and the changes in color were evaluated. The study aimed to determine whether ultrasound treatment caused any undesirable color degradation in the juice. Additionally, the researchers measured the concentration of ascorbic acid, a vital antioxidant, to assess the impact of sonication on the nutritional quality of the juice.Furthermore, the study examined the effectiveness of sonication in inactivating yeast, a common spoilage microorganism in fruit juices. The researchers evaluated whether ultrasound treatment could contribute to microbial stability and extend the shelf life of the tomato juice.

[3]. Effect of ultrasound and steam treatments on bio accessibility of β-carotene and physicochemical parameters in orange-fleshed sweet potato juice Evelyn Alicia Rios-Romero a , Luz Araceli Ochoa-Martínez a,* , Luis Arturo Bello-Perez b , Juliana Morales-Castro a , Armando Quintero-Ramos c , Jose Alberto Gallegos-Infante a

The study conducted by Rios-Romero et al. investigated the effects of ultrasound and steam treatments on the bioaccessibility of β-carotene and physicochemical parameters in orange-fleshed sweet potato juice. The research aimed to determine the impact of these non-thermal preservation techniques on the release and availability of β-carotene, a vital antioxidant and provitamin A compound, in the juice. Assessing the bioaccessibility of β-carotene is essential for understanding its nutritional impact and potential health benefits for consumers.Additionally, the study evaluated changes in physicochemical parameters such as color, pH, and viscosity resulting from ultrasound and steam treatments. These parameters are crucial for determining the overall quality and consumer acceptance of the juice.The findings contribute valuable insights into the potential benefits of non-thermal preservation techniques for orange-fleshed sweet potato juice. The research sheds light on how these treatments may enhance the nutritional value and quality of the juice, promoting its utilization as a rich source of provitamin A in the diet.