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EFFECT OF ULTRA-FILTRATION, BENTONITE AND POLYVINYLPOLYPYROLIDONE TREATMENTS ON PARTICLE SIZE DISTRIBUTIONS OF INDIVIDUAL JUICES AND JUICE BLENDS

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ABSTRACT: *The obtained results could be summarized in the effect of ultrafiltration, bentonite and PVPP treatment on particle size distributions of individual juice [orange (O), mango (M) and guava (G)] and juice blends were investigation. Results showed that Bn-treatment removed 86, 84 and 100% volume of particle size in MJ, OJ: MJ and OJ:GJ, respectively but only 37% in straight OJ compared to the untreated samples. These results may be attributed to the removal of the biggest particle size in OJ and leaving the smallest particle size causing low turbidity, and still stable cloudy orange juice with no PME enzyme activity. Besides, from microscopic observation, the obtained photomicrographs showed that the particles which remained after Bn-treatment of OJ, GJ or OMJ blend were smaller than those of the untreated samples but, were realy of the same size for the Bn-MJ treatment and the untreated MJ. Furthermore, microscopic examination of the tested samples indicated that Bn-treatment was preferred to produce on OJ or on OMJ blend of high quality with little PME enzyme activity and no sedimentations compared to the untreated samples, but these continued to be cloudy in spite of the treatments used. In addition, the size of particles was rather large in OJ, but is small in MJ and from the microscopy and laser diffraction, although not in exact agreement, it was noticed that the size of many particles were reduced after Bn-treatment of the straight individual juice or its blend as compared to the untreated juice. Besides, a great correlation between turbidity results and certain particle-size distribution characteristics could be established found for all juices under investigation and their blends.*

Key Words: *Bentonite, polyvinylpolypyrolidone, ultra-filtration, Particle size, juice, blends, orange, mango, guava, pectinmethyesterase, sedimentation, turbidity, microscopic.*

INTRODUCTION

Conventionally, fruit and vegetable juices are preserved by pasteurization, which inactivates degradative enzymes and kills spoilage microorganisms but also may impart cooked flavors to heat-sensitive products. In addition, high temperatures, required for sterilization, often cause coagulation, flocculation and precipitation of some components. The food industry has given increasing attention in recent years to meet consumer demands for Afreshness in processed foods by pursuing the development of minimally processed products (Sapers, 1991). Such characteristics might be achieved in raw fruit juices, cold-sterilized and preserved by refrigeration, if enzymatic processes associated with quality loss during storage such as enzymatic browning and loss of cloud stability could be prevented. Most recent reviews have concentrated on technology for improvement of juice quality without adding chemicals and without use of heat pasteurization. Pasteurizing juice usually results in off-flavor formation, and addition of chemicals will also affect flavor and color (Cantarelli, *et al.* 1989; Knorr, 1993 and Anon, 1996). However, fruit juices prepared without heat treatment are subject to loss of cloud stability. Loss of cloud stability has been attributed primarily to the de-estrification of pectin by pectin methyl esterase enzyme (Wicker, *et al.* 1987 and Hou and Marshall 1995).

Blending of fruit juices is thought to be a convenient alternative to improve their organoleptic quality as well as the nutritive value of the product (Sandhu and Sidhu, 1992). A few studies have been reported (Flora, 1979; Mokady, *et al.* 1984; Spayed, 1984; Rizk, *et al.*1985 and El-Shiaty, *et al.* 1986) on blending of fruit juices. Appearing to those consumers, looking for a different kind of taste or mouth feel, these beverages may be formulated with a wide range of tropical flavors or flavor blends such as banana, orange, guava, and strawberry and lime (Donald, 1995). Blending of fruit juices is thought to be a convenient means of improving their organoleptic quality as well as the nutritive value of the product (Sandhu and Sidhu, 1992). However, the problem of controlling cloud instability is more difficult with juice blends since substrates and enzymes come from several sources. Therefore, the present work was designed to study improvement of the sensory quality of juice blends by cloud instability (by removing the pectinesterase enzyme) in products prepared without heat pasteurization. This was done by processes that do not alter flavor or color, using no additives, and leaving no residues.

A fine suspension of particulate material, known as cloud, contributes substantially to quality factors such as color, flavor, and texture of citrus juices. Most research on citrus cloud has dealt with the causes of its instability in orange juice, a problem which is mainly due to insoluble factors in the juice and which can usually be prevented by appropriable storage for up to 6 months at 4°C. Cloud instability may also be encountered when citrus-flavored beverages are formulated, and in such cases the problem residues in the nature of the cloud particles. Failure to keep the cloud particles in suspension is often the cause of quality loss in orange juice and beverages. A better knowledge of the basic components and of the chemical and physical properties of cloud should lead to a better understanding of its stability as well as to other ways to improve its quality (Klavons and Bennett, 1985).

The main problem with cloudy fruit juice production is the assurance of maintains vitamin C, color, PME-activity, cloud stability and particle size distribution. During cloudy orange juice processing a large percentage of insoluble particles is retained in suspension, maintaining a light opaque color. Several procedures were published (Daher *et al* (2005), Genovese *et al*, 1997, Ouden and Vliet (1997), Dietrich, *et al.* (1996) and Baker *et al*, 1991, Hodgson, *et al.* (1990), Owusu-Yaw, *et al.* (1988), Jewell, 1981), Mizrahi and Berk (1970)). However, Pectin associated with small, suspended particles within the serum contributes to the juice cloud (*Klavons, et al, 1994*). The quality defects are primarily due to the activity of pectinesterase, PE which could be found mainly in the peel, the rag and juice sac tissue (Galal, 1986).

Therefore, the objectives of this study are to determine whether the tendency of raw fruit juices and blends to the cloud stability maintained by removing fractions responsible for these defects without affecting flavor, color or aroma. Such juice, if cold pasteurized, could be used to produce a refrigerated product with the characteristics of a fresh juice. Hence, the scope of the present investigation was devoted to study The effect of addition of fining agents (e.g. bentonite and PVPP) and ultrafiltration on cloud stability and particle size of the studied individual juices and their blends. The aim of this work was to assess the effect of ultrafiltration, bentonite and polyvinylpolypyrolidone treatments on particle size distributions of individual juices and juice blends using particle sizer and electronic microscopic and to compare it with a conventional heating system under similar conditions.

MATERIALS and METHODS

1- Juice preparation:

Mature Valencia orange (*Citrus sinensis*), green mango (*Mangifera indica*, L.) and green guava (*Psidium guajava*, L.) fruits grown in the United State of America (USA) were purchased from a local supermarket in Philadelphia and kept at 3 - 4°C until needed. Juicing was performed at room temperature. Orange, mango and guava fruits were sanitized before making juice by immersing for 1min. in 200ppm Cl_2 (Sodium hypochlorite solution, NaClO) and then rinsing with water to remove the Cl_2 residue. All of the equipment and glassware used to produce the juice were sanitized by immersion in 1000ppm Cl_2 (Sodium hypochlorite solution, NaClO), pH 6.5 (adjusted with citric acid) for 1min and then rinsed with water to remove the residue. All containers in which the juice was to be held were autoclaved in a AMSCO Scientific, SV-120, (USA) at 121°C for 30min.

1-1- Orange (O) fruits were rinsed with water, cut in halfs and the orange juice extracted using a screw type citrus juice extractor (Betty Crocker, High Performance Appliance, Inc, Danbury, CT). The extracted juice was strained under suction through a Spectra /Mesh7 Woven Polymer Filter (polypropylene, macroporous filters), mesh opening: 297um (Spectrum7, Houston, Texas), to remove seeds and albido fragments and to reduce the pulp content.

1-2- Mango (M) fruits were rinsed with water, sectioned to longitudinal slices, and juiced with an Acme Supreme Juicerator Model 6001 (Acme Juicer Mfg. Co., Lemoyne, PA) lined with a 46 x 57cm strip of Whatman No.1 filter paper. Juice was collected in a beaker containing 1% antifoam emulsion (Sigma Chemical Co, St Louis, MO), to prevent foaming during extraction of the juice, and ascorbic acid (5mg/100ml juice) with stirring. The ascorbic acid was used to prevent instantaneous browning, thereby providing a short lag time to allow test materials (insoluble polyvinylpolypyrrolidone (PVPP), insoluble B-cyclodextrins, etc.) to be added and mixed. The amount of ascorbic acid used was not enough to prevent browning alone for more than 1hr (Sapers, *et al*, 1989).

1- 3- Guava (G) fruits were rinsed with water, cut into small pieces and pureed in a Warring blender for 2-3min with 0.5% (v/w of pulp) Clarex7 ML, which is a food grade commercial enzyme mixture standardized for pectinase, hemicellulase, and cellulase activities. These enzymes were derived from controlled fermentations by selected strains of *Aspergillus niger* and *Trichoderma reesei* (Solvay Enzymes, Elkhart, IN). The function of Clarex ML enzymes are the clarification and stabilization of single strength juice, increased extraction of color and flavor components, and increased overall juice yield (volume and soluble solids). The puree was incubated in a water bath at 50°C for 2hr. Following the enzyme treatment, juice was extracted with an Acme Supreme Model 6001 Juicerator lined with a 46 x 57cm strip of Whatman No.1 filter paper.

2- Juice Blends:

Blending of fruit juices was considered to be a suitable approach to improve their organoleptic quality as well as their nutritive value. In the study described below, the primary goal was to develop a means to predict susceptibility of orange, mango and guava juice blends to browning. 50 -100 % proportions of orange, mango and guava juices were combined to prepare the following blends, as shown in Table 1.

Table (1): Proportions of orange, mango and guava juices in juice blends.

Kind of juice	Blend of juices (%)					
	1	2	3	4	5	6
Orange juice (OJ)	100	-	-	50	-	50
Mango juice (MJ)	-	100	-	50	50	-
Guava juice (GJ)	-	-	100	-	50	50

3- Juice treatments:

3-1- Fining treatments

3-1-1- polyvinylpolypyrolidone (PVPP) treatments :

The phenolic substances in fruits, which are subject to oxidative changes during processing, are responsible for browning of the juice. The synthetic PVPP is capable of binding phenolic compounds so that they cannot undergo oxidation by polyphenoloxidase.

Aliquots (50ml) of the studied juices were poured into beakers containing as test materials 0.5% PVPP (Sigma7 Chemical Co., St Louis, MO), with 0.1% sodium benzoate (SB) and untreated mango juice. The prepared Juice samples were stirred for 10min at 400rpm, then centrifuged for 10 min at 1000 rpm (127 xg), and the supernatants were poured into optical cells for reflectance measurements at room temperature. Samples were kept at 25°C for up to 24 hours with stirring (see 3-1-5).

3-2- Treatments to stabilize turbidity in juices:

3-2-1- Ultrafiltration (UF) membrane filtration treatments:

The purpose of UF was to remove the soluble fraction of pectin methyl esterase (PME) enzyme (which causes cloud instability) from orange juice to improve product quality and maintain cloud stability. Orange juice has higher PME activity (1.56unit/ml) than mango or guava juice (0.71 and 0.53 unit/ml respectively). To remove PME enzyme from orange juice and to obtain cloud-stable juice, the following procedure was used:

Orange juice was passed through 62 mm diameter DIAFLO ultrafiltration membrane (Amicon, Inc. Beverly, MA) having molecular weight cut-off (MWCO) values of 30,000 Dalton under pressure of 60 Psi at 4°C. The orange juice permeate was combined with fresh mango juice or fresh guava juice (1:1). The orange Juice permeate was also combined with fresh mango juice, then (UFOJ: MJ) blend was treated with 0.5%PVPP.

3-2-2- Clarification by treatment with fining agents:

As noted earlier, fining agents are used to remove hazes and haze-forming materials from juices. Commonly used fining agent is much more economical than an ultrafiltration system and is more effective in obtaining clarified juice. A 5% slurry of Bentonite (Sigma Chemical Co., St Louis, MO) in water, dispersed with a Polytron homogenizer (Brinkmann Instruments

Co., Inc., Westbury, NY) was added to juice samples at levels corresponding to 1000 ppm (0.1%) bentonite (Bn) to 100ml portions of freshly prepared juice. This was stirred for10 min at 400 rpm, and centrifuged at 1000 rpm (127xg) for 10min. Then, orange juice supernatant was mixed with fresh mango juice or fresh guava juice as described previously in 3-2-2. The 0.1% bentonite treated orange Juice supernatant was also combined with fresh mango juice or fresh guava juice, then (BnOJ:MJ) or (BnOJ:GJ) blend was treated with 0.5%PVPP.

4- Analytical methods:

4-1- Measurement of sedimentation (%):

Sedimentation was measured by the method of Krop and Pilnik (1974) where Juice samples were left standing undisturbed at room temperature after which the height of the sediment was measured in mls and expressed as %-age of the total sample height in a 50ml cylender.

4-2- Cloud (Turbidity) measurement:

Turbidity of the juices was determined using a turbidimeter (DRT-100B,HF7 Scientific, Inc., Fort Myers, Florida City, FL) and reported as Nephelometric Turbidity Units (NTU). The Certified Reference Standard supplied with this instrument is a pure liquid having a nominal value of 0.02 NTU was used.

4-3- Particle size analysis:

Particle size of the suspended substances was determined using an Accusizer7 370 with a Sub-Micron Particle sizer7 Autodilute Model 370, NICOMP (Particle Sizing Systems, Inc., Santa Barbara, CA). A 2 ml aliquot of the sample was diluted with 2 ml of distilled water and injected into the autodilute port of the Accusizer7 370. The particles were counted through a single particle optical sizer. Mean distributions were reported. The distribution was fitted to a Gaussian distribution with Coefficient of Variance (C.V.) less than 3% (with Extinction< 20 nm^3; this means that the particle sizes less than 20 nm^3 were not resolved).

4-4- Microscopic determination of particle size:

Preparation of fruit juice for particle size analysis by microscopy was carried out as follows: 10 µl of prepared juice (diluted 1:100) were placed on one end of a microscope slide, streaked across the slide with a cover slip, and air dried. Using a 20x objective, a 1 second exposure was taken (1 pixel=0.46 µm, field 576 x 384 pixels) with a Nikon Diaphot Inverted Microscope (Optical Apparatus, Co., Nikon Inc., NY) and STAR 1 Cooled CCD camera (Photometrics, LTD, Tucson, AZ). Particles (ranging between 2-200 square µm) were measured using IPLAB (Ver. 3.0) Image Processing Software, Signal Analytics (Vienna, VA).

4-5- Statistical Analyses:

Analyses for experiments were performed in duplicate, and results were averaged. Statistical analyses for linear regression, correlation, and analysis of variance (ANOVA) were conducted. Statistical analysis were performed for the juice blends experiment with the Statistical Analysis System (SAS, 1995) software system (Cary, NC). The responses from the mixture design (section 2) were analyzed by using response surface regression procedures as implemented in the ADX (Automated Design of Experiments) module of the SAS Software system. The contour and surface plots for the triangular coordinates used in mixture designs were obtained by using the plotting options from the ADX module. Further analyses were performed using the correlation and regression procedures of the SAS software system. Mean, standard errors and analysis of variance (ANOVA) were performed using the super ANOVA software (Abacus concepts, Inc., Berkeley, CA). A Duncan >s Multiple Range Test was carried out by means of the Ashortest significant ranges-SSR ≅ (Larmond, 1974) to determine the differences between the treatments.

RESULTS AND DISCUSSION

1- Effect of ultrafiltration, bentonite and PVPP treatment on particle size distributions of juice and juice blends:

One of the major problems facing the producer of orange juice is to produce a product with a consistent and stable level of cloud. A detailed knowledge of the volume or particle size distribution in orange juice should be useful in understanding this problem (Jewell, 1981). The same author reported that the most important factors in cloudy juice are size, number and volume of particles present and their stability.

Citrus juices contain particles that are referred to collectively as cloud. These particles play an important role in establishing organoleptic properties that are directly related to juice quality.

The objective of this part of the study reported hereln was to measure the particle size (PS) distribution of juice and juice blends using (a) an accusizer7 370 with a sub-micron particle sizer 7 instrument (particle size systems) counted through a sample particle optical sizer to quality variations in particle volume, intensity and number. (B) applying a wider range of electron microscopy techniques, to the study of the particles in individual juice, juice blend and the treated juice.

2- Particle size distribution using particle optical sizer:

Particle size distribution (Volume, intensity and number), turbidity and sedimentation of an untreated and an UF, Bn and PVPP treated juices are listed in Table 2, from which it could be noticed that the Bn and PVPP treatment of MJ, OJ:MJ and OJ:GJ greatly reduced the volume of particle size (nm^3) to 7361, 3402 and < 20nm^3, respectively. as Compared to 50840, 20938 and 15456 in the untreated samples. Yet, turbidity readings (NTU) decreased to 461, 499 and 64 in MJ, OJ: MJ and OJ: GJ resp. as compared to 1103, 1250 and 1226 in untreated respectively samples. Besides, the volume of particle size (nm^3) decreased to 12814 in the 0.1%Bn-treated OJ as compared to 20345 in the untreated sample, but turbidity reading (NTU) of Bn-treated OJ was greatly reduced to 139 as compared to 1315 in the untreated sample. However, the volume of particle size and turbidity were reduced to < 20nm^3 and 0.34 NTU, respectively. In the UF-OJ treated juice using 30K-MWCO membrane. Besides, no sedimentation was found in all Bn, UF and PVPP treatments of the individual juice or the prepared juice blends, (Table 2). Furthermore, Bn. treatment had a great effect on guava juice turbidity. Results showed that turbidity decreased from 68 NTU to 19 NTU when using 0.1% Bn. Normally, using 0.1% Bn reduced the volume of particle size which affects intensity and number of particle size, as shown in Table 43. In addition, from the same results, it could be concluded that Bn-treatment removed 86, 84 and 100% volume of particle size in MJ, OJ: MJ and OJ: GJ, respectively. But removed only 37% in OJ compared to the untreated samples. These results may be attributed to the removal of the biggest particle sizes in OJ and left the smallest particle size causing low turbidity, yet still stable cloudy orange juice was attained with no PME enzyme activity. Similar results were obtained by Rouse (1951 & 1953) in a study on the relationship between pectin esterase activity in Valencia orange juice and water insoluble solids and increased pulp content. However, the pulp content in citrus juice consists mainly of rag and juice sacs, both of which contain a high percentage of pectin and a high activity of pectin methyl esterase enzyme. As pulp levels are increased in citrus juices these factors may be expected to influence the degree of gelation and clarification.

Venolia *et al,* (1974) suggested that processing profoundly affects particle-size distribution in lemon juice. Because juice properties, such as turbidity and particle settling rate, are related to the particle-size distributions, it is of interest to explore the effects of processing upon such distributions. This is where the particle size distribution in the untreated and the treated juices were analyzed using laser light scattering technique and analyzing the data by the Fraunhofer theory. Particle size (PS) analyzers based on laser light scattering principles can measure juice PS distributions. This type of quantitative PS information can be expected to facilitate more precise interpretation and control of PS oriented juice product quality attributes such as stability and turbidity (Getchell and Schlimme, 1985). It has been earlier reported that the proportion and size distribution of suspended solids play a part in determining the physical behavior of tomato products (Bhasin *et al*, 1988).

Table (2): Effect of ultrafilteration (UF), bentonite (Bn) and polyvinylpolypyrrolidone (PVPP) on distribution of particle size, turbidity and sedimentation of individual juices and their blends.

Juice treatments	Particle size				
	T.Volume* (nm^3)	Intensity (nm^3)	Number	Turbidity (NTU)	Sedimentation (ml /100ml)
Untreated orange juice (OJ)	20345.0	6977.0	1339.0	1315	58
0.1% Bentonite-orange juice	12814.0	4702.0	957.0	139	0.00
OJ-UF-30k-MWCO	<20	<20	<20	0.34	0.00
Untreated mango juice (MJ)	50840.0	14296.0	2384.0	1103	10
0.1% Bentonite-mango juice	7361.0	3029.0	678.0	461	0.00
Untreated Guava (GJ)	<20	<20	<20	68	0.00
0.1% Bentonite-guava juice	<20	<20	<20	19	0.00
Untreated – OJ:MJ blend	20938.0	6822.0	1285.0	1250	46
0.1% Bm OJ:MJ-0.5% PVPP	3402.0	1831.0	557.0	499	0.00
Untreated OJ:GJ blend	15456	5512.4	1189.5	1226	48
0.1% Bm OJ:GJ-0.5% PVPP	<20	<20	<20	64	0.00

* Total particle volume.
* using Gaussian analysis (with Extinction <20 nm)
The intensity is the particle contributed the most scattering .
The volume-weighted is what size contributes the most volume.
The number-weighted is where the largest population of particles is located.

3- Particle size distribution using electron microscopy:

The fine particles of suspended material are responsible for the colour, appearance and much of the flavour of citrus juices. Without these particles which are known collectively as the Acloud orange juice would be little more than a clear, almost colour less sour-sweet liquid of no particular value. Failure to keep the cloud particles in suspension is often the cause of quality loss in orange juice and its beverage (Mizrahi and Berk, 1970).

From the obtained results in this investigation it was noticed that particle-size distributions of unpasteurized individual juices and their juice blends varied appreciably but showed, nevertheless, a relatively constant pattern where large particles generally made a small contribution to the total volume of detectable particles.

Individual juice or juice blends particle size distributions are plotted by numbers of measurement against the area of particles size diameter (µm), as seen in figures 1 to 4. Where particle-size distribution results were analyzed with the help of numerical methods. Where, Figs. 1 - 4 represents the relationship between area of measurement numbers of particle size (µm) and type of processing. Plots of differences between successive size distributions revealed how particle size changes were related to effective particle diameter and type of processing.

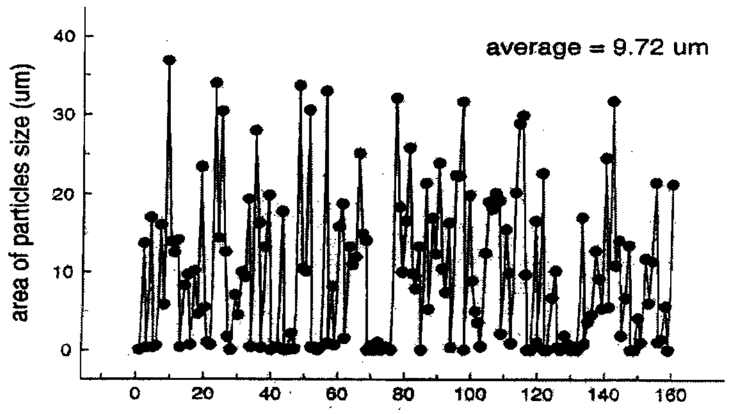


Fig 1a. Particle size distribution of fresh orange juice

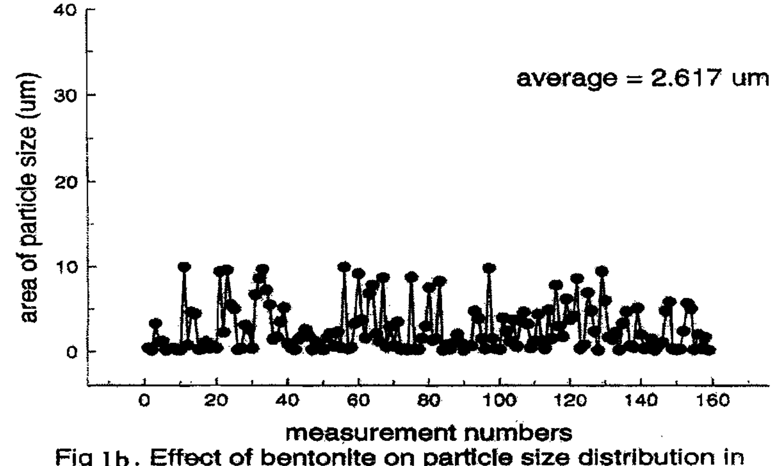


Fig 1b. Effect of bentonite on particle size distribution in orange juice

The obtained results show that, juice turbidity results and certain particle-size distribution characteristics appeared to be related. However, the plots showed that the larger particles in fresh orange juice (9.72 µm) were removed by using of bentonite as compared to smaller particles (2.617 µm) as seen in Figs. 1a,b. Similar data was noticed in fresh guava juice, since the larger particles in fresh guava juice (5.7 µm) were removed by using bentonite to

smaller particles (0.935 µm), as seen in Figs. 3a,b. Yet, no difference was noticed on applying bentomite to mango juice. However, the average of particle size was 2.885 µm in the fresh mango juice and 2.816 µm in the bentonite treated juice (as seen in Figs. 2a, b).

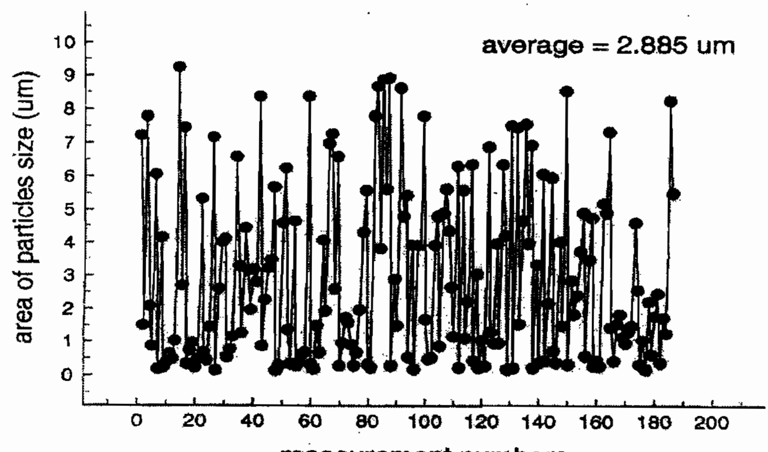


Fig 2a. Particle size disribution of fresh mango juice

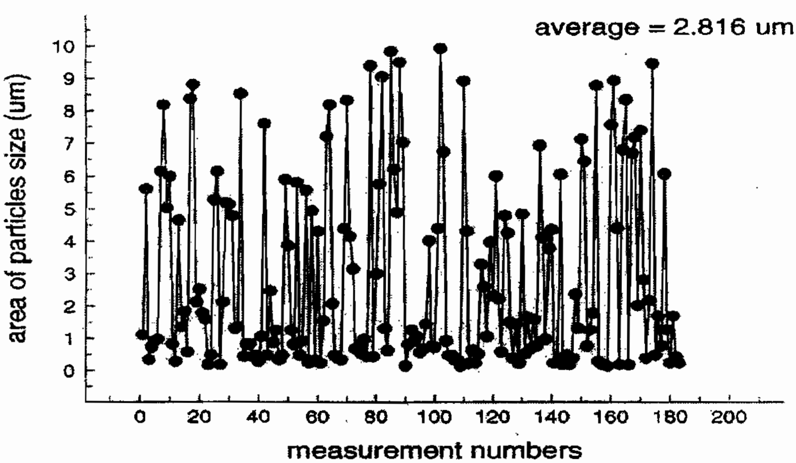


Fig 2b. Effect of bentonite on particles size distribution in mango juice

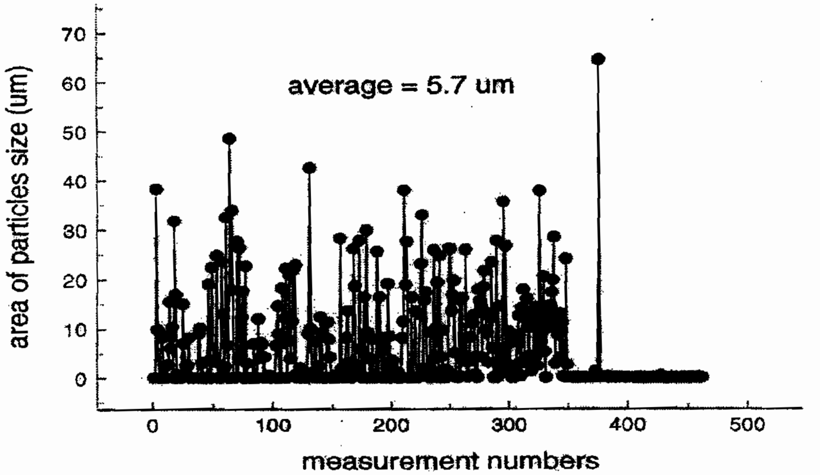


Fig 3a. Particle size distribution in fresh guava juice

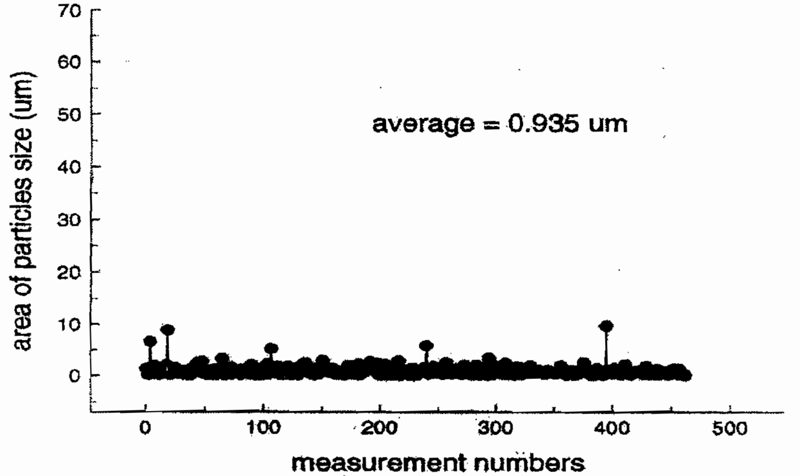


Fig 3b. Effect of bentonite on particle size distribution of guava juice

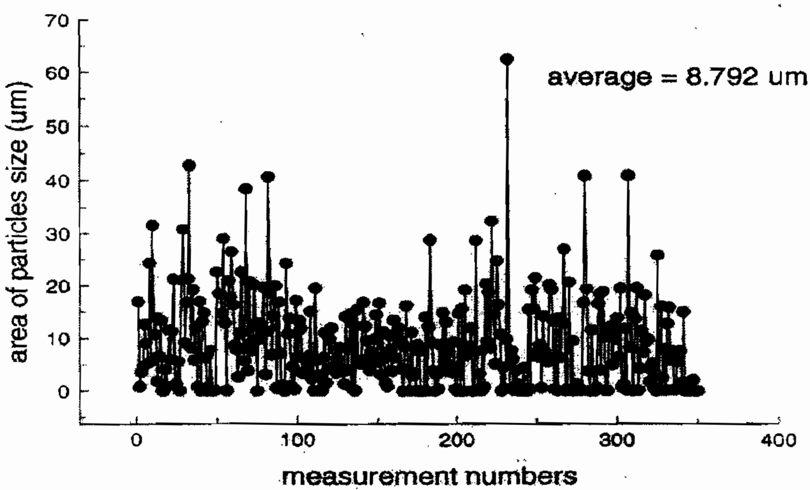


Fig 4a. Particle size distribution of fresh orange mango juice

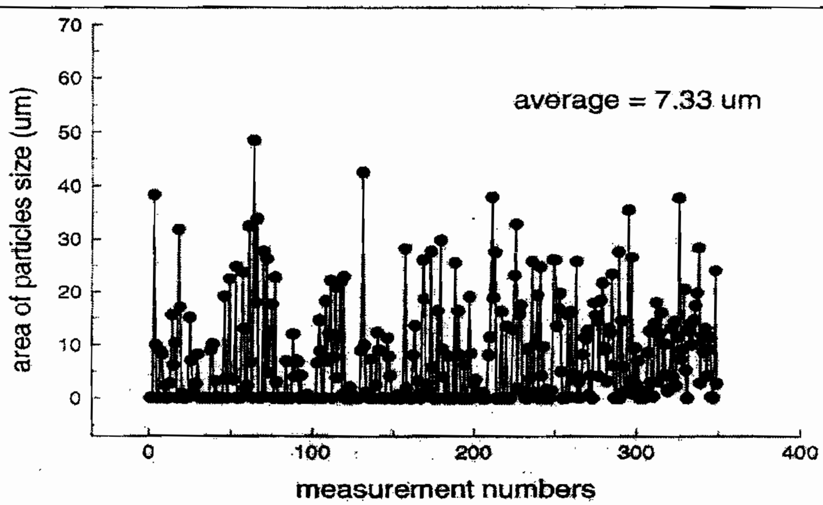


Fig 4b. Effect of bentonite and PVPP on particle size distribution in orange mango juice blend

As expected the average size of the Bn-treated juice particles in the resulting suspensions was clearly smaller than in the untreated samples. Meanwhile, the fresh orange juice contained large particle size (9.72 μm) and fresh mango juice contained small particle sizes (2.885 μm). Besides, the results in Figs. 4a,b show that fresh orange mango juice blend particles size was not affected by Bn-PVPP treatment. However, the particles size was reduced from 8.792 μm in fresh OMJ blend to 7.33 μm in Bn-PVPP-OMJ blend. The results in Figs 3 a,b indicate that no cloud instability occurred in guava juice probably because it had a low PME enzyme activity as well as lower turbidity and smaller particle size.

Furthermore, the data of particle-size distribution (Figs 1a -3a) show that in the untreated juice it varied considerably, and that the properties of the OJ or OMJ. Bn-treated juice was strikingly different, although the turbidity of the Bn-treated juice was smaller than that of the untreated juice. This is the clearest case yet encountered of the correlation of high turbidity with small modal diameter and narrow particle-size distribution (Venolia, *et al,* 1974).

Recently, Ichwan and McLellan, (1995) observed changes in particle size distribution, number and volumes of particles over time. McIntosh apples exihibited a change in particle size distribution over an 8 - week's storage period. They also established a relationship between changes in particle size distribution, loss of cloud and formation of sediment.

Besides, Bhasin, *et al,* (1988) observed microscopically the nature of pulp particles, their shape and size in cold and hot break tomato juice. This is why microscopic examination of the prepared juices and their blends was carried out. The microscopic observation of Figs 5 to 8, the photomicrographs show that particles which had remained after Bn-treatment of OJ, GJ or OMJ were smaller than those of the untreated samples. Yet, similar sizes, were nearly noticed, for the Bn-MJ treatment and the untreated MJ. Furthermore, microscopic examination of the studied samples indicate that the Bn-treatment was preferred to produce OJ or OJ: MJ blend with high quality and little PME enzyme activity and no sedimentations as compared to the untreated samples, yet the juice was still cloudy after the studied treatments.

These data refer to that the size of particles is large in OJ, but it is small in MJ. Results from microscopy and laser diffraction, although not in exact agreement, show that the size of many particles were reduced after Bn-treatment of individual juice or juice blend compared to untreated juice.

It might be concluded that, with respect to individual juice or juice blends, juice turbidity results and certain particle-size distribution characteristics appeared to be related.

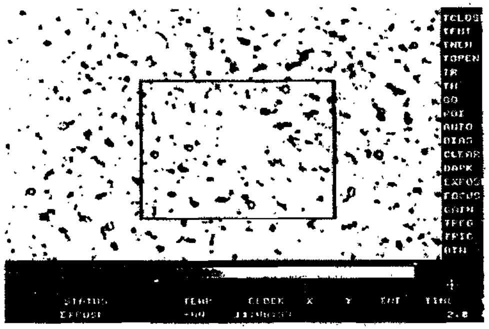


Fig 5 a. Photomicrograph of untreated orange juice.

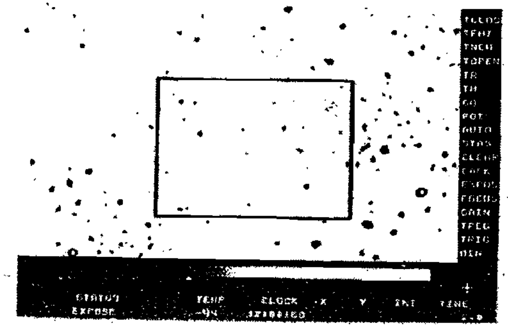


Fig 5 b. Photomicrograph of 0.1%Bn-treated orange juice.

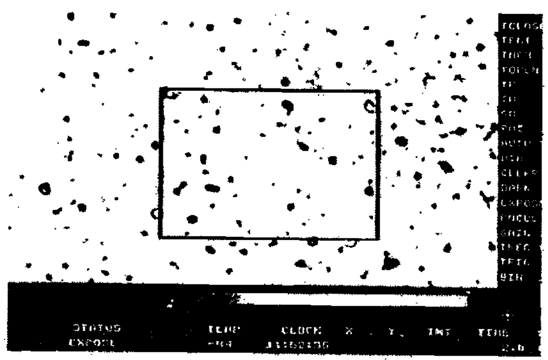


Fig 6 a. Photomicrograph of untreated mango juice.

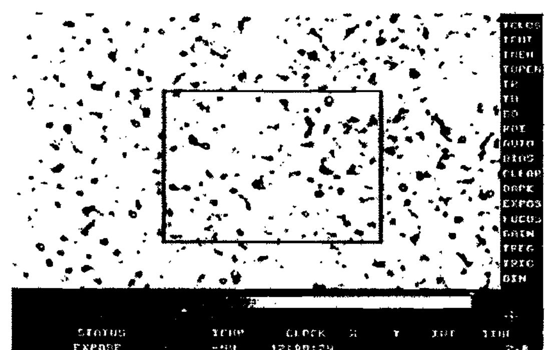


Fig 6 b. Photomicrograph of 0.1%Bn-treated mango juice.

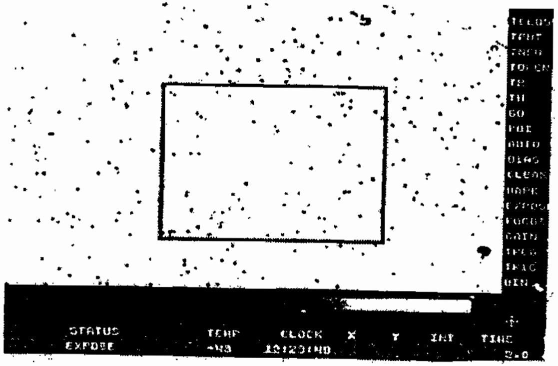


Fig 7 a. Photomicrograph of untreated guava juice.

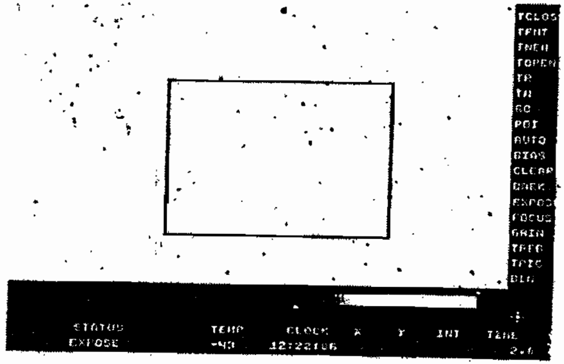


Fig. 7 b. Photomicrograph of 0.1%Bn-treated guava juice.

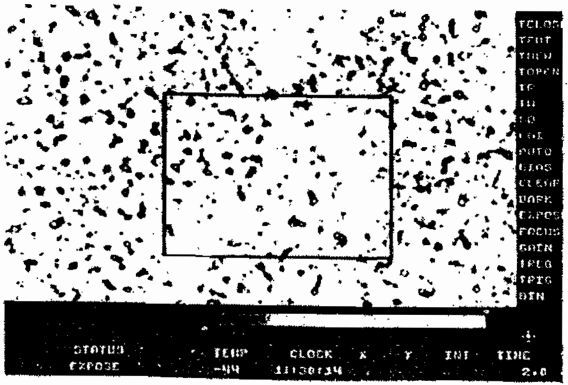
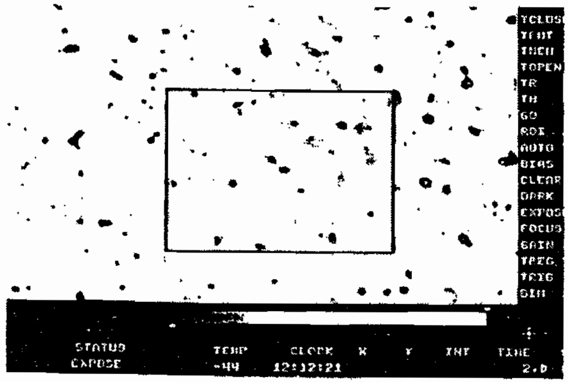


Fig 8 a. Photomicrograph of untreated orange mango juice blend.



Fog 8 b. Photomicrograph of 0.1%BnOJ:MJ-0.5%PVPP treated orange mango juice blend.

The present results lead to the following conclusions:

A combination of electron microscopy, particle size analyzer and computerized image analysis are powerful tools for studying morphology-property relationship in fresh juice or fresh juice blends and treated juice. Besides, a bentonite treatment was more effective in removing the large particles in orange juice and guava juice than the small removal of particles in the studied mango juice. Thus, the treatment of orange mango juice blend with Bn - PVPP is recommended to obtain a juice blend of a high quality, with an extended shelf-life and acceptable turbidity having little PME enzyme activity suffering, no sedimentation and rather browning resistant.

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تأثير الترشيح الفوقى و البينتونيت و البوليفينولبيروليدون على توزيع حجم الجزيئات للعصائر و مخالطها

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الملخص العربى

تم دراسة تأثير الترشيح الفوقى و البينتونيت و البوليفينولبيروليدون على توزيع حجم الجزيئات للعصائر (البرتقال و المانجو و الجوافة) و مخالطها.

و قد أوضحت النتائج ان معاملة البينتونيت قد أدى إلى أزالت ٨٦ و ٨٤ و ١٠٠% من حجم الجزيئات فى عصائر المانجو و خليط البرتقال بالمانجو و خليط الجوافة بالبرتقال على الترتيب على حين كانت فقط حوالي ٣٧% فى عصير البرتقال مقارنة بالعينات الغير معاملة.

النتائج تشير إلى ازالة الجزيئات الكبيرة فى عصير البرتقال و الاحتفاظ بالجزيئات الصغيرة مسببه عكارة منخفضة مع ثبات العكارة لعصير البرتقال و عدم وجود نشاط انزيم البكتين ميثيل استيريز.

و مع ملاحظة ان الفحص بالميكرسكوب الالكترونى المتحصل عليها و التى تبين ان الجزيئات التى تتبقى بعد المعاملة بالبينتونيت لكل من عصير البرتقال و الجوافة و مخلوط البرتقال و المانجو كانت أصغر من الجزيئات للعينات الغير معاملة و لكن نفس الجزيئات لمعاملة عصير المانجو بالبينتونيت و عصير المانجو الغير معامل.

و أيضا الفحص الميكرسكوبى للعينات المختبرة تشير الى ان المعاملة بالبينتونيت كانت أفضل لانتاج عصير برتقال أو خليط من البرتقال و المانجو كجودة عالية و بنشاط انزيمى منخفض و لا يوجد ترسيب مقارنة بالعينات الغير معاملة.

بجانب انة يوجد علاقة كبيرة بين نتائج العكارة المتحصل عليها و توزيع حجم الجزيئات فى كل العصائر المختيرة و مخاليطها.