Journal of Experimental Food Chemistry

Ignatyeva, J Exp Food Chem 2016, 2: 110
DOI: 10.4172/2472-0542.1000110

Research Article Open Access

Production of Cloudifier Products from Lemon, Orange, Melon, Persimmon Fruit and its Automation

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Received date: January 21, 2016; **Accepted date:** May 18, 2016; **Published date:** May 25, 2016

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Abstract

Objective: An increase of cloud stability and cloud level of cloudifier juices and concentrates of citrus, melon and persimmon fruit considerably increased their sensory characteristics and beneficial health properties. The aim is to develop the cloudifier juice technology using the continuous process of flash vacuum expansion in the industry of cloudifier juice.

Materials and methods: A systematic search of the database literature up to 2014 for studies on the cloudifier juice production was conducted according to a methodology developed a priori. The property and cloud stability of cloudifier juices and concentrates from citrus, melon and persimmon fruit was determined using standardized methods.

Results: Evidence from the selected studies were used to develop the industry production of cloudifier juices and concentrates from citrus, melon, persimmon fruits The cloudifier juice and concentrate from citrus, melon, persimmon fruits were obtained using the cavitation, enzyme treatment and flash vacuum expansion. The technology relates to the method that prevents the gel formation, intense browning and re-increase of astringency. The few important basic conditions, such as the enzyme treatment at low temperature, 2.8-4.4 mS electrical conductivity and the sudden expansion treatment during 30 min, formed the pectin oligomer with 60% degree of esterification, micelle (1.0-1.3 µm) network. The application of proposed procedure considerably increased the turbidity to 5000-14940 FNU in 8.0-11.2 °Brix reconstituted juice. The thermal treatment of cloudifier samples at 85-95°C not accelerated the sedimentation process. Cloudifier industry concentrates after cooled were stable for longer too. From an engineering point of view, the micelle size to complete solubilization is a critical process indicator and it determined the electrical conductivity. The relationship between turbidity and conductivity in cloudifier juices from citrus, melon, persimmon fruit was offered for control and automation in processing.

Conclusions: This technology which is able to modify the pectin chains and form the micelle network was used in the industry production during a large period of time. During these period 60 lots of industrial cloudifier lemon and orange concentrates were analyzed. The cloudifier fruit juice and concentrate from citrus, melon, persimmon fruit has much benefits potential over their fruit juices and concentrates with a higher pulp, such as:

- more natural colour
- the turbidity more than 56870 FNU in the 8.0-11.2 °Brix reconstituted juice with a low content of the pulp (0-0.4%; 0.04-1.0% in industry products)
- longer shelf life

In summary of these study findings, it was found that the content of modified pectin was high and this level satisfied the inhibition of cancer cell proliferation. Further studies are required to quantitatively determine the effect of particle size distribution and cloud loss of the cloudifier juice.

Keywords: Food production; Cloud stability; Micelle; Turbidity; Conductivity; Citrus; Melon; Persimmon fruit

Introduction

It has been known that there is a relationship between our health and food. In this regard, the juice (lemon, orange, persimmon fruit, melon) which contains the largest amount of pectin, modified pectin [1], soluble fibre [2], citrus flavonoids, vitamin C, large amounts of vitamin A [3] and lycopene [4-6], antioxidants is the natural product with beneficial health properties. In the previous study [7] observed that the modified pectin will be effective against cancers of the breast, colon and pancreatic cancer, and melanoma. For example, the inhibition of cancer cell proliferation (HT29 colon line) was obtained from the sample of modified pectin by using 1 g to 1 L concentration.

The inhibition of cancer cell proliferation (SW480 colon line) was obtained with the modified pectin sample by using 2 g to 1 L concentration too. The slight decrease in cell viability (JIMT1 cell line) relative to the control at the two concentrations employed was obtained for the modified pectin sample. The inhibition of cancer cell proliferation (B16/f10 cell line) was obtained with the modified pectin sample by using 2 g to 1L concentration.

From the nutritional point of view, persimmon fruit and persimmon fruit' juice contains large amounts of vitamin A and lycopene, antioxidants, soluble fibre and pectins. Lycopene considerable input gives this result such as a great antioxidant power that can act to protect cells from oxidative stress produced by the action of free radicals. This cell phenomenon is responsible for major cardiovascular diseases and certain types of cancer and aging [4,5].

The high content of vitamin A (carotene and cryptoxanthin) persimmon brings, among other beneficial properties for viewing, embryonic development, bone growth, menstrual cycle and other aspects of female reproduction [3]. In recent articles the authors also showed through theoretical analysis and certain analytical approximations that the higher content of pectins, modified pectins may increase the cloudiness and cloud stability [8].

The cloudifier juice or cloudifier concentrate can be produced cloud stable with the application of suitable processes. The production of cloud products is closely linked with enzyme technology. The cloudifier fruit juice or cloudifier fruit concentrate were produced by way of a five-stage or six-stage process. This process consists of enzyme treatment of the juice, juice mash, juice pulp for the premium cloudifier juice, cloudifier juice or cloudifier concentrates, respectively. The literature discusses different models for building a stable colloidal particle.

Historically the DLVO of colloid stability has described these interactions. The colloidal particles contain a core which is positively charged [9,10] and is surrounded by a carbohydrate shell, consisting among others of negatively charged pectins. Electrical conductivity is an important and useful indicator and its valor can be used to predict and control the stability of cloudy systems, such as the cloudifier juice and cloudifier concentrate. The ionization of positively charged core and stability of micelles are sensitive to the ionic strength and pH of the aqueous phase. An increase of cloud stability and cloud level of cloudifier juices and concentrates of citrus, melon and persimmon fruit considerably increased their sensory characteristics and beneficial health properties.

The present work was based on the earlier conclusions. The cloud loss process was accompanied by an increase in the low methoxy pectin content and a decrease in the soluble pectin content and an increased sedimentation rate. This phenomenon was explained by the direct action of methyl pectin esterase or pectin esterase. Consequently, micelles may be changed by pectin esterase action. From Stokes' law it follows that the rate of sedimentation can be reduced by the following case: diminishing the difference in density by raising the density of the continuous phase, by lowering the density of the particles.

The distribution of charges in the electrical double layer of spherical micelle plays a significant role in the stability of cloud systems. Generally, the cloud particles do not settle independently. They hinder each other e.g. by electrical and steric interaction. Also it was noted that both mechanical and thermal factors affect the cloud stability.

The sum of phenolic substances was significantly higher in the cloudifier juice or cloudifier concentrates than in the corresponding premium cloudifier juice. The role of phenolic substances (hesperidin) in cloud loss was determined by the density of them [8]. It was showed that the contribution of hesperidin to cloud loss might not be negligible.

The aim is to develop the cloudifier juice technology using the continuous process of flash vacuum expansion in the industry of cloudifier juice. Specifically, this work focuses on the technology it prevents the gel formation, intense browning, re-increase of astringency and it takes to form the micelle stability. The other aim of this paper is to present results of the relationship between soluble solids, pulp content, turbidity and the conductivity, colloidal stability by applying conductivity for automation in the cloudifier juice production from the citrus, melon and persimmon fruit.

Materials and Methods

Electrical conductivity

The electrical conductivity was determined with a Malvern Zetasizer 3000 (Malvern Instruments Inc., London).

Measurement of the quantity of settled pulp

The quantity of settled pulp was measured according to an American standard [11]. The pulp content is defined as the portion of the cloud particles with settles when 50 ml juice in a graduated tube with a conical bottom are centrifuged for 10-50 min at 1500 rpm. The pulp content is expressed in %v/v.

Measurement of the turbidity

The turbidity was measured in a HI 88713 Turbidimeter (Hanna Instruments) in formazin nephelometric units (FNU) at 860 nm. Samples of the juice and of the supernatant were placed in a 10 ml cell (cuvette), capped, and gently inverted twice to ensure even mixing. An aliquot (15 ml) is placed in a graduated conical centrifuge tube. These tubes are centrifuged for 10 min at 1500 rpm. The supernatant are brought into glass cuvette for measurement of the turbidity.

Measurement of total phenols

Phenolic compounds were determined according to the Folin-Ciocalteu [12] with our changes in the extraction procedure of the sample. Phenolic compounds were measured at 765 nm.

Measurement of phenolic acids

Determinations of mayor phenolic acids were done according to the method of Garcia-Sanches and et al. [13] with our changes in the extraction procedure of the sample, using methanol.

Measurement of particle concentration

The particle concentration, C (g/L), of each sample was determined as follows. A certain volume (20 ml) of juice was micro-filtered through a 0.45 μm cellulosic membrane (E04WP04700, MSI, Westboro, MA), such that all the juice particles were retained in the filter paper, which was previously weighed. Finally, the filter with the particles was vacuum dried at 55-60°C overnight, and weighed. Determinations were made at least in duplicate [14].

The Imhoff test

The Imhoff cone has been used [15] for sedimentation monitoring and stability monitoring. The sample (16 g) of each cloudifier concentrate was deposited to 1 L of distilled water (leaving room in the container for rinsing during volume transfer and shaking). Suspended sample was brought to 1 L volume of Imhoff cone. The volume of sediment was read from the Imhoff cone after 24 hours [16].

Keeping of samples and measurement of cloud stable

The samples are held in stoppered glass tubes (100 ml, ⌀20 mm) at a room temperature at 14 days.

Viscosity measurement

The procedure for the testing absolute viscosity by the traditional Brookfield rotary method was performed at the shear rate of 50/s at room temperature. The absolute viscosity is reported in mPa×s.

The degree of methyl-esterification

The degree of methyl-esterification (DME) of pectin glycopolymers was determined by the method described by Femenia et al. [17], and by the method described by Nelina et al. using a conductivity meter [18]. The degree of methyl-esterification (DME) of pectin glycopolymers was expressed as percent methoxy groups.

Statistical analysis

All measurements were performed in triplicates (n=3) and the values were averaged and reported along with the standard deviation (± S.D). Multivariate analysis (factorial analysis and correlation matrix) of data was performed by using Statgraphics V.7.1 program.

Results and Discussion

Cloudifier juice production from persimmon fruits

The cloudifier juice technology from citrus, melon, persimmon fruits was developed. There are two types of persimmons: astringent and non-astringent. A typical treatment of astringent persimmon fruits is in cold storage with 95% carbon dioxide for 24 hours at 20°C, after which the soluble tannins have become non- astringent forms [19]. Our technology relates to a method for producing cloudifier juices from two types of persimmons without this treatment.

The persimmon fruit is a difficult product to industrialize because when transformed into puree it also tends to gel quickly and suffers intense browning. Moreover, if heat treatment is applied there is intense retention in acidic conditions; non-astringent tannins are hydrolyzed and soluble tannins result, which become astringent puree. However, our technology relates to the method that prevents the gel formation, intense browning and re-increase of astringency.

In industry the technology of production of cloudifier juices from persimmons was applied comprising the following steps: crushing, cavitation treatment, separating the juice from the pulp, straining of same pulp until a puree or paste is obtained, enzymatic treatment with enzymes having activity on pectins, hemicelluloses, treatment with sudden expansion (vacuum flash) and others.

As mentioned, the persimmon fruit is chopped before the other process steps, which facilitates grinding. The persimmon crushed pulp is ground by cavitation treatment to obtain a fine paste with particle size less than or equal to 0.2 mm. The cavitation treatment is used to break down of suspended particles, cells and colloidal liquid compound [20].

The cavitation treatment also prevents gel formation. Then the paste is incubated with enzymes for between 20-40 minutes. As a result of the enzymatic treatment, Brix of the suspension increased (Figure 1) from 14.0 to 15.5-16.0 and to 17.6; pH changed from 5.70-5.95 to 5.4-5.1; the viscosity decreased from 9000-13000 mPas x s to 1000-5500 mPas x s (Figure 2A and 2B). The suspension after undergoing incubation with enzymes had been deaerated.

For this, the suspension is introduced into a vacuum flash to remove most of the dissolved air. This deaeration is per formed to further inhibit the activity of the Polyphenol oxidase, removing part of the oxygen dissolved in the suspension (paste or puree persimmon). As explained below, the removal of oxygen is achieved. In addition to deaeration, there is the decrease in viscosity, the acidity change, changes in the structure of pectin molecules, the conditions for the formation of micelles and the increase of ascorbic acid to 100 mg/L, which captures a part of this oxygen.

Regarding the incubation step which previously crushed and screened persimmon pulp, it is determined that pectinlyase; endo-1,4-beta-glucanase and combinations thereof can be used. Also for other fruit pulp it is determined those enzymes such as, polygalacturonase, rhamnogalacturonase, arabinase, endoglucanase mannase, xylanase and cellulase and any combination thereof can be used for the incubation step.

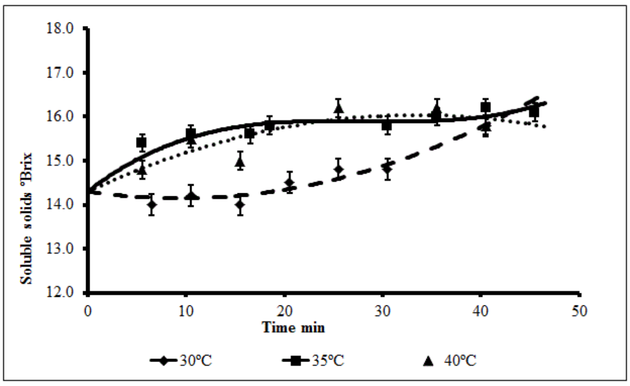

Figure 1: The kinetics of °Brix in the persimmon suspension by exposed of the enzyme treatment.

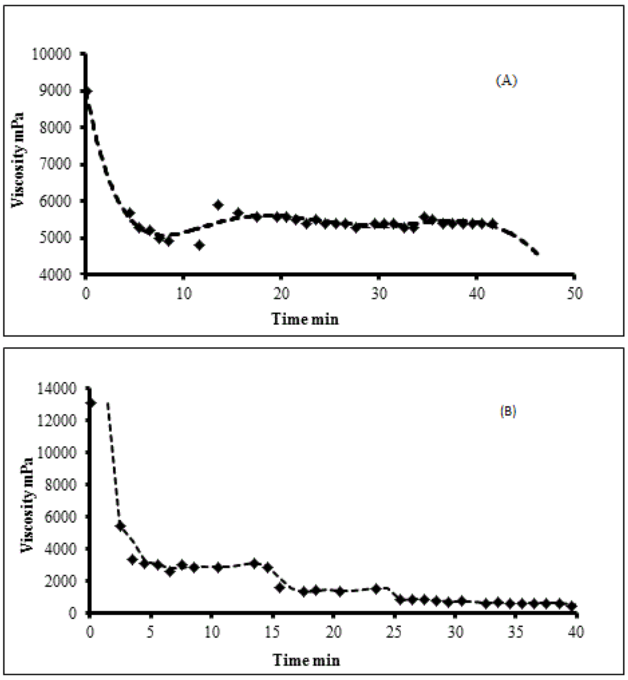

Figure 2: The kinetic change of viscosity in the persimmon suspension by exposed of the enzyme treatment. (A- without the pre-treatment) and (B- with the pre-treatment).

Enzyme application conditions such as the time and the temperature largely depend on the enzyme used, and the content of tannins. The enzyme treatment was applied both for astringen and non-astringent persimmon fruits. Lower temperature and time (20-40 min) reduced the content of phenolic compounds in the juice, or pulp from between 0.18-0.20% to 0.08% (Figure 3).

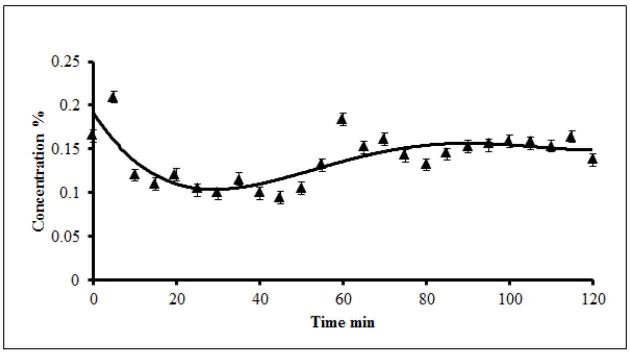

Figure 3: The kinetics of phenolic compound concentration in the persimmon suspension (Std. Err. 7 x 10-3- 3.5 x 10-3) by exposed of the enzyme treatment.

The cavitation treatment, the flash vacuum expansion [21] is novel technologies. The study of the sudden expansion opens the possibility to produce the cloud stability juices. The sudden expansion (vacuum flash) occurs immediately after an enzyme treatment. The sudden expansion treatment of persimmon juice during 30 min reduces the amount of phenolic compounds in the juice, or pulp from 0.08% to 0.04%. If we increased the time of the sudden expansion treatment from 30 min to 135 min the amount of phenolic compounds in the juice, or pulp has increased from 0.05% to 0.12%. For better understanding of this process, the key effects of flash vacuum expansion parameters (initial pressure, etc.) were studied on juice quality, cloud stability and yield of persimmon juice. The results showed:

- The sudden expansion treatment is an effective method to raise the quality and profitability of the production of cloud stability juices.
- The value of °Brix is increased and then decreased in the persimmon juice and pure (Figure 4). The maximum of °Brix is ranging from 16.8 to 17.6 (for the persimmon juice, the persimmon pure). The value of °Brix in the industry persimmon juice is changed from 14.1-15.9 to 16.1-18.1 by exposed of the enzyme and sudden expansion treatment.

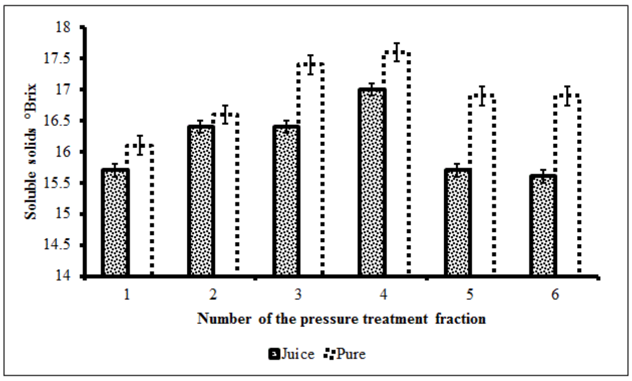

Figure 4: Variation of °Brix pure and °Brix juice of persimmon fruits by exposed of the sudden expansion treatment.

- The concentration of soluble polyphenols is changed in the persimmon juice and the minimum of the soluble concentration is 115 ppm (Figure 5). The concentration of soluble polyphenols in the industry persimmon juice is changed from 428 ppm to 99-193 ppm by exposed of the enzyme and sudden expansion treatment.

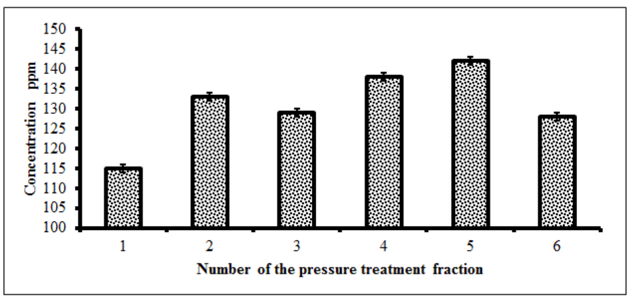

Figure 5: Variation of soluble polyphenol concentration in the persimmon juice by exposed of the sudden expansion treatment. SD=1.

- The yield of juice is changed and the maximum of yield is ranging from 40 to 41%. The maximum of yield of the industry persimmon juice is ranging from 37 to 50% by exposed of the enzyme and sudden expansion treatment.
- After treatment of the persimmon juice and pulp the degree of esterification of soluble pectin is changed. The sudden expansion treatment of cloudifier juices from persimmon fruit modified the pectin substances and formed the molecules with 60% degree of esterification (Figure 6).
- The sudden expansion treatment reduces the viscosity to 1300-1410 mPas x s.
- The sudden expansion treatment decreases the pH of juice to 4.58-4.51. The value of pH of the industry persimmon juice is ranging from 4.22-5.66 pH of the industry by exposed of the enzyme and sudden expansion treatment.

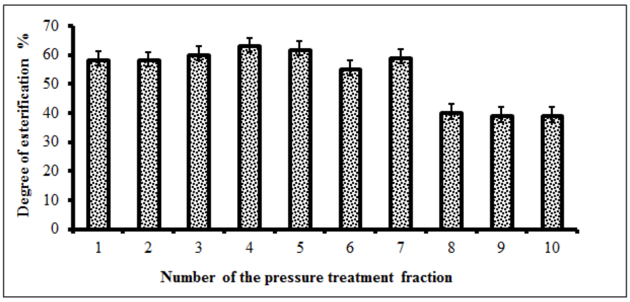

Figure 6: Variation of degree of etherification in the premium cloudifier persimmon fruit juice by exposed of the sudden expansion treatment.

Our studies indicate that flash vacuum expansion is a potential substitute for the production of cloudy persimmon, melon juices and of cloudy premium lemon juice. The sudden expansion treatment of premium juice changes: the content of settled pulp, the pectin methylesterase activity, the particle charge, the precipitation formation. However, more research is needed to improve the continuous process prior to application in the industry. Additionally, a comparison of juice colour obtained by the different treatments indicated that the flash vacuum expansion caused a more natural colour than other treatment types. So the parameters of L^*; a^*; b^* of the industry persimmon juice are ranging from 37.6-82.9; 0.61-42.3; 18.1-75.0 (SD=0.01-0.12) by exposed of the enzyme treatment with the sudden expansion treatment, respectively. The parameters of pantone of the industry persimmon juice are ranging from bright orange to orange; from butterscotch to saffron by exposed of the enzyme treatment with the sudden expansion treatment.

The cloud stability

Studies of °Brix, electrical conductivity, turbidity, rheology, and sedimentation of juices were used in order to obtain the industrial stable cloudifier juice and concentrate from citrus, melon and persimmon fruits. The results showed that the increase in soluble solids (°Brix) led to the increase in electrical conductivity by the following equation y=-0.0229x2+0.7856x+0.018. It was observed that electrical conductivity increased to 4.5 in a linear way to 7.5 °Brix (Figure 7). The pulp content increased with an increase the electrical conductivity (Figure 8). The relationship between pulp content and electrical conductivity was a polynomial and fitted the following equation: y=0.2193x2 – 1.3504x + 2.3527. The cloudifier juices contained a minimum quantity of pulp at 2.8-4.4 mS.

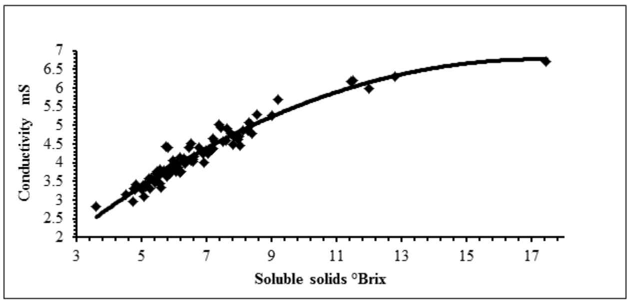

Figure 7: Effect of soluble solids (°Brix) on the electrical conductivity of the cloudifier industrial juice.

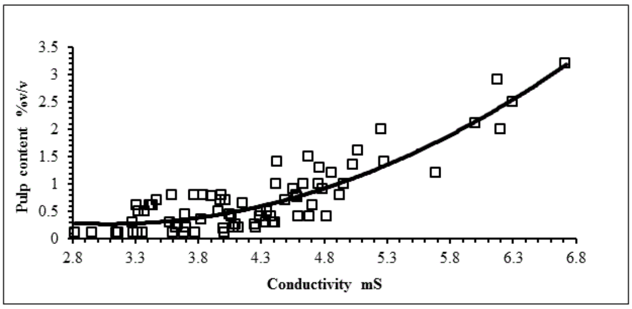

Figure 8: Variation of pulp content in the cloudifier industrial juice.

The turbidity, pulp content, particle concentration of obtained cloudy products didn't change during 10-20 min of centrifuging due to the constancy of the average hydrodynamic diameter of micelles. Cloudifier juices and concentrates contained 0-0.4% v/v pulp. The pulp content few changed during 20-50 min of centrifuging. Values of turbidity change were considerably lower as compared with other studies [13]. The lower value of turbidity change was attributed to the variety fruits used in the cloudifier juice production. Also, the lower value of turbidity change was attributed to the automation of the cloudifier juice production from citrus, melon and persimmon fruits. The increase of cloud level of cloudifier juices, concentrates of citrus, melon and persimmon fruit considerably increased their sensory characteristics and beneficial health properties.

It was studied the effect of thermal factors on cloud stability. The result indicated that the thermal treatment of cloudifier samples at 85-95°C not accelerated the sedimentation process. It was determined that the increase of time factor of the thermal treatment during concentration of the premium cloudifier juice, cloudifier juice from melon led to the increase of the cloud loss and alteration of the colour parameter. The Figure 9 showed the cloud loss in the industry premium cloudifier melon concentrate between 38-40 °Brix. The content of settled pulp in the 10 °Brix reconstituted juice increased from between 0.2-0.4% v/v to 3-4% v/v.

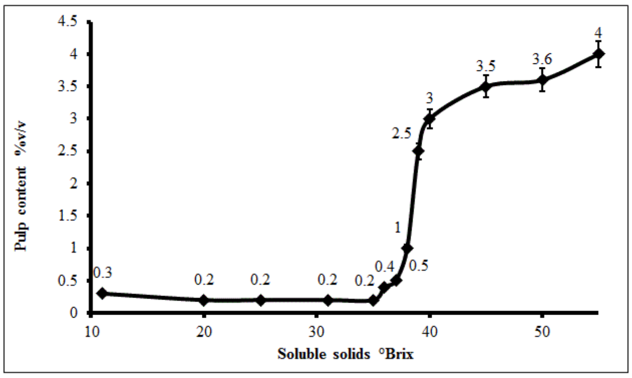

Figure 9: Variation of pulp content in the cloudifier industry melon concentrate.

The turbidity and visual judgment of relative turbidity of reconstituted juices were then compared during the experiment as a function of time. Date of Table 1 showed that cloudiness of the supernatant such as degree of turbidity decreases by + one or + two or +three at 14 days (room temperature). The cloud loss in industry cloudifier lemon concentrate has a maximum of 21.0-38.4% during storage. This cloud loss was probably because the destruction of the micelle network. The turbidity ranged from 3750-4250 FNU at 14 days for a reconstituted juice of 8 °Brix. The effect of time storage on colour parameters for a reconstituted juice of 8.0-11.2 °Brix had to be determined during 14 days. The colour parameters of cloudifier concentrate (35-40/40-46 °Brix) from melon showed little differences between the control sample and samples during storage. It was also observed that the colour parameters of premium cloudifier concentrate (more than 40/46 °Brix) from melon showed significantly higher differences between the control sample and samples during storage. The industry premium cloudifier concentrate of 55 °Brix showed a higher change of colour parameters (brightness from 5.69 to 4.19; hue from 145 to 138) probably due to the effect of time factor of the thermal treatment.

Sample	4 days	14 days
Cloudifier lemon juice	++++++++	+++++++
Premium cloudifier lemon juice	+++++	+++++
Cloudifier lemon concentrate	++++++++	+++++++
Cloudifier orange concentrate	+++++++	++++++
Cloudifier persimmon fruit juice	++++++	++++++
Premium cloudifier persimmon fruit juice	+++++	+++++
Cloudifier melon juice	++++++++	++++++
Premium cloudifier melon juice	++++++++	+++++
Premium cloudifier melon concentrate	++++++++	++++++

Table 1: Visual judgment of relative turbidity after 4, 14 days. The more turbid the sample is the more + signs it gets.

The freezing effect and the storage on cloud stability of the cloudifier concentrate from citrus, melon, persimmons was studied. Samples were stored at -20°C during 60-180 days. Samples were analysed to compare the change in the cloud stability of cloudifier concentrates made from citrus and of cloudifier juices made from melon. The turbidity, cloud stability, pulp content, sedimentation in Imhoff Cone didn't showed differences between the control sample and frozen samples. As expected cloudifier industry concentrates after cooled were stable for longer too.

The micelle formation

Enzymes activities which can maintain cloudiness were used for micelle formation and inactivation of pectin esterase. It was observed that the application of proposed procedure considerably increased the turbidity to 5000-14940 FNU in 8.0-11.2 °Brix reconstituted juices. Also, the application of pectinlyase, endo-1,4-beta-glucanase, cellulase and any combination thereof led to the formation of pectin oligomers with 60% degree of esterification. The recent results showed that the increase of oligomer pectin content with 60% degree of esterification led to the cloud stability of juices from citrus, melon and persimmon fruits. The cloud systems of samples were stable due to formation of micelle (1.0-1.3 μm) network and modification of continuous phase viscosity by means of pectin oligomers with 60% degree of esterification. As expected, that our data have got good the agreement with the DLVO theory. As noted above stable colloidal systems from fruits can be obtained by using the enzyme treatment without the flash vacuum expansion. This procedure which is able to modify the pectin chains and form the micelle network was used in the industry production during a large period of time. During these period 60 lots of industrial cloudifier lemon and orange concentrates were analyzed (Tables 2-4).

Parameter/No.	1	2	3	4	5	6	7	8
°Brix	35.0	40.3	31.4	43.8	37.8	45.2	35.6	42.8
Acid, % w/w	14.3	16.2	10.8	16.6	14.4	20.6	13.5	20.1
pH	2.92	2.94	2.84	2.95	2.85	2.88	2.99	2.76
Pulp, % v/v*	0.20	0.40	0.40	0.50	0.70	1.00	1.00	0.80
Oil, % w/w*	0.003	0.003	0.002	0.022	0.003	0.004	0.004	0.003
Flavonoids, % w/w*	0.51		0.43	0.42	0.45			
Imhoff test, % w/w, 24-48 h*	1.4	0.1	0.8	1.1	4.6	3.3	2,8	3.5
Ascorbic acid, mg/L *	563	510		546	510	575	743	694
Turbidity, FNU*	5687	6073		6339	6234	5753	7428	6942

Table 2: Cloudifier lemon concentrates with low acidity. *8 °Brix reconstituted juice.

Table 2 presented that the turbidity ranged between 5687-7428 FNU in the 8°Brix reconstituted juice of industry cloudifier lemon concentrates. Tables 2 and 3 presented that the pulp, the Imhoff test in the 8°Brix reconstituted juice of industry cloudifier lemon concentrates and of premium cloudifier lemon concentrates ranged between 0.04-1.00 % v/v; 0.1-4.6 % w/w, respectively. Tables 2 and 3 presented that the acid concentration, pH in industry cloudifier lemon concentrates and premium cloudifier lemon concentrates ranged between 10.8-35.7% w/w; 2.45-2.99, respectively. Table 4 presented that the turbidity, the pulp in the 11,2°Brix reconstituted juice of industry cloudifier orange concentrates ranged between 3283-7550 FNU; 0.4-0.9% v/v, respectively. Table 4 presented that the acid concentration, pH in industry cloudifier orange concentrates ranged between 0.71-2.75% w/w; 3.65-4.54, respectively. The industry cloudifier orange concentrate (Table 4, No.3) showed a lower turbidity parameter probably due to the effect of 0.71% w/w acid concentration or of the thermal treatment.

Parameter/No.	1	2	3
ºBrix	47.8	41.3	41.7
Acid, % w/w	35.7	31.1	31.8
Pulp, % v/v*	0.04	0.10	0.10
pH	2.45	2.45	2.53
Oil, % w/w*	0.0002	0.0002	0.0004
Imhoff test, % w/w, 24-48 h*	0.2	0.2	0.6

Table 3: Premium cloudifier lemon concentrates. *8 °Brix reconstituted juice.

Parameter/No.	1	2	3	4
ºBrix	44.3	41.9	41.6	40.8
Acid, % w/w	2.75	1.73	0.71	2.48
Pulp, % v/v**	0.90	0.60	0.40	0.40
pH	3.86	4.14	4.54	3.65
Oil, % w/w**	0.008	0.002	0.002	0.010
Turbidity, FNU **	7550	5182	3283	7250

Table 4: Cloudifier orange concentrates. **11,2 °Brix reconstituted juice.

The automation

The relationship between turbidity and conductivity in cloudifier juices from citrus, melon, persimmon fruit was offered for automation in processing. Results of this relationship provided useful information, which was industry tested, on the mechanism of the interaction between enzymes, flash vacuum expansion, conductivity and micelle sizes during the automation of cloudifier juice productions. The goal of automation:

- is to reduce human action in certain situations
- is to increase quality and performance of cloud products
- is to achieve by automation the required level of electrical conductivity
- The used automation is able to detect the trigger, activate the runbooks, run the scripts in the defined order, and then report the result of the runbooks
- Trigger - server the electrical conductivity, Brix, pulp content, turbidity
- Runbook - activates a series of scripts, in a specific order, to perform by the polynomial equations and lineal equations in the interval of the electrical conductivity (4.2-4.8 mS); °Brix (6.4-8.0), pulp content (0.6-0.9% v/v)
- Scripts- manipulate of the activity of enzymes, such as pectinlyase, endo-1,4-beta-glucanase, cellulase and pressure of the flash vacuum expansion
- Report the result of the runbooks is the electrical conductivity and a means of the micelle size

From an engineering point of view, the micelle size to complete solubilization is a critical process indicator and it determined the electrical conductivity and other parameters of the corresponding process equipment, such as the automation.

Conclusion

The cloudifier juice and concentrate from citrus, melon, persimmon fruits were obtained using the cavitation, enzyme treatment and flash vacuum expansion. This technology which is able to modify the pectin chains and form the micelle network was used in the industry production during a large period of time. During these period 60 lots of industrial cloudifier lemon and orange concentrates were analyzed. The cloudifier fruit juice and concentrate from citrus, melon, persimmon fruit has much benefits potential over their fruit juices and concentrates with a higher pulp, such as:

- More natural colour
- The turbidity more than 56870 FNU in the 8.0-11.2 °Brix reconstituted juice with a low content of the pulp (0-0.4%; 0.04-1.0% in industry products)
- More longer shelf life

In summary of these study findings, it was found that the content of modified pectin was high and this level satisfied the inhibition of cancer cell proliferation.

The turbidity, cloud stability, pulp content, sedimentation in Imhoff Cone didn't showed differences between the control sample and storage samples, frozen samples during 60-180 days.

The quality of cloudifier product from citrus, melon, persimmon fruit is quite dependent on the operating parameters. Thus, an understanding of factors affecting the micelle formation, the colloidal system properties is required for the process optimization and automation, in order to obtain products with better sensory and nutritional characteristics, with pectin oligomers will be effective against cancers of the breast, colon and pancreatic cancer, and melanoma. It was determined that the thermal treatment of cloudifier samples at 85-95°C not accelerated the sedimentation process. Finally, it was determined the range of relationship between turbidity and conductivity. This relationship between turbidity and conductivity in cloudifier juices from citrus, melon, persimmon fruit was offered for automation in processing.

The technology of the persimmon cloudifier product production was described. An optimization of technology factors increased the yield (more 37%), modified the astringe polyphenols, decreased the concentration of soluble polyphenols (99-193 ppm), reduced the viscosity (1000-1410 mPas x s.).

Further studies are required to quantitatively determine the effect of particle size distribution and cloud loss of the cloudifier juice.

Acknowledgements

An author greatly acknowledges all co-workers, "CITROMIL", MURCIA, SPAIN
for their support and .lab collaboration of citric products.

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