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Effect of different clarifying agents on the sensory and Rheological properties of grape juice concentrate

Masoome Hatamikia[1], Ali Mohamadi Sani[1]*, Shahin Zomorodi[2]

[1]Food Science and Technology Department, Quchan Branch, Islamic Azad University, Quchan, (IRAN)

[2]Department of Agricultural Engineering Research, Agriculture Center, Urmia, (IRAN)

E-mail: mohamadisani@yahoo.com; msani@iauq.ac.ir

ABSTRACT

Grape juice concentrate (GJC) is a traditional product of grape-harvesting areas of Iran which is generally produced from the year-end harvest of poor quality. In order to examine the effect of different clarifying materials on the quality of GJC, a plan was executed using factorial statistical method with completely randomized design. The first factor was type of clarifiers in six levels, comprising grape juice concentrate soil (GJCS), bentonit, silicasol, gelatin-bentonit, gelatin-silicasol, gelatin-bentonit-silicasol; and the second factor was the quantity of clarifiers at three levels with three replicate. Results of statistical analysis showed that treatment of GJC using clarifying agent containing gelatin, bentonit and silicasol resulted to the lowest viscosity (223.6 cp) vs. to the bentonit-silicasol complex which led to the highest viscosity (257.3 cp). Sensory evaluation analysis showed that samples treated with clarifying agents containing 5% GJCS; 6% bentonit; 2% gelatin-6% bentonit -5% silicasol gained higher scores than the others and sample treated using 3% GJCS gained the lowest score.

KEYWORDS

Grape juice concentrate;
Clarification;
Grape juice;
Filter-aid.

INTRODUCTION

Grape juice concentrate with the local name of Dooshab,is a traditional product of grape-harvesting areas of Iran, produced from boiling and condensation of grape juice to the brix over 70-80%, in open containers or in vacuum, and without adding sugar or other additives[5,10]. Grape juice concentrate contains high volumes of natural sugar, minerals, vitamins A, B_1, B_2 and C, organic acids and antioxidants. It, therefore, plays an important role in the nutrition of various age groups, especially children and athletes[1,9,17,18]. GJC is quickly absorbed by the body as a result of its high volume of digestible monosaccharide. It is, therefore, useful for those weakened as a result of a chronic disease or after undergoing a medical operation[1,5,10,15,16]. GJC is a rich source of chemical elements essential to human body, such as copper, zinc and iron. Iron contained in GJC may be useful in the treatment of anemia patients [3,17]. Clarification ways of GJC are similar to those of clarification of grape juice. In fruit juice industry, clarification is a unified process that comprises the elimination of undesired color and flavor; turbidity; bitterness and gassy[12]. In the process of clarification, clarifiers are utilized which are combined with charged particles of fruit juice such as protein, pectin and phenolic materials and are consequently separated from the environment. Usual clarifiers in fruit juice industry are bentonit, gela-

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tin and silicasol. Bentonit is a kind of clay of montmorillonite group with the characteristic of shallow absorption surficial absorption, and affects proteins, poly-phenolic materials, metal ions and the rest of the toxics[7]. The soluble protein gelatin is obtained through relative hydrolysis of collagen existing in animal skin, bones and cartilage. In terms of extraction method, gelatin is divided into acid (A) and alkaline (B) variants[14]. Gelatin characteristics include decreasing the quantity of polyphenols and pectin, making complex with natural proteins of fruit juice and brightening the color of fruit juice. Silicasol is another clarifier which helps to brighten the color of the fruit juice through creating negative charge in fruit juice and flocculating with positively charged compounds[7,12].

This study also made use of a certain white soil called GJCS as the clarifier material in the production of GJC. In addition to depositing suspending material, the soil neutralizes the acidity of the grape juice[20]. Bodbodak et al.[6] studied the effect of different clarification treatments on the rheological characteristics of pomegranate juice. Şengül et al.[15] and Yogurtcu and Kamýslý[18] studied rheological characteristics of mulberry and grape extracts, and Arslan et al.[3] and Alpaslan and Hayta[2] studied rheological and sensory characteristics of GJC and sesame assortment dough with a spinning viscometer. The present study aimed to analyze the effect of different clarifiers on the quality of GJC.

MATERIALS AND METHODS

Materials

Grape (*Razeghi* variety) was harvested from the gardens of Nazloochay district in Urmia. Material used for clarification including bentonit (SIHA, Paranit Na-Ca bentonit), gelatin (mesh 35, type A, bloom 80, DGF Stoess), commercial silicasol 15% (Baykisol 15%) and calcium carbonate (Charleaux brand, EU0) was provided by Saroone Co. Urmia. Also, GJCS was obtained from the GJC producers in Urmia.

Methods

Production of GJC

Fifty four samples of GJC (including six treatments in three levels and three repetitions) produced around early October 2011 in the research center of ministry of agriculture in Urmia (TABLE 1). For each sample, about 5 liters of grape juice squeezed from 10 kg of grape by a juicer (Toshiba, Japan), and the pH, acidity and brix of the juices were measured. GJCS reduces acidity and eliminates materials blurring the grape juice. The soil was first dissolved into part of grape juice and then added to the samples and was thoroughly mixed. After 2-3 hours, GJC cracks on the surface. At this time the existing foam should be removed from the surface and sieved through a piece of percale. In all other treatments, the acidity of grape juice was set off by calcium carbonate (42.5 g/5 liters of grape juice) to the final pH=8.5. Then the clarifying agents were added and the juice was sieved by a piece of percale after 30 minutes. All samples were finally transferred to the cooking section and concentrated to brix=70±2.

TABLE 1 : Clarifying agents used in GJC

Treatments[a]	Clarifying agent	Concentration
T_{1-A}	Soil	3(g/100ml)
T_{1-B}	Soil	4(g/100ml)
T_{1-C}	Soil	5(g/100ml)
T_{2-A}	Bentonit	4(g/lit)
T_{2-B}	Bentonit	5(g/lit)
T_{2-C}	Bentonit	6(g/lit)
T_{3-A}	Silicasol	5(ml/lit)
T_{3-B}	Silicasol	6(ml/lit)
T_{3-C}	Silicasol	7(ml/lit)
T_{4-A}	Gelatin + Bentonit	2(g/lit) + 4(g/lit)
T_{4-B}	Gelatin + Bentonit	2(g/lit) + 5(g/lit)
T_{4-C}	Gelatin + Bentonit	2(g/lit) + 6(g/lit)
T_{5-A}	Gelatin + Silicasol	2(g/lit) + 5(ml/lit)
T_{5-B}	Gelatin + Silicasol	2(g/lit) + 6(ml/lit)
T_{5-C}	Gelatin + Silicasol	2(g/lit) + 7(ml/lit)
T_{6-A}	Gelatin + Bentonit + Silicasol	2(g/lit) + 4(g/lit) + 7(ml/lit)
T_{6-B}	Gelatin + Bentonit + Silicasol	2(g/lit) + 5(g/lit) + 6(ml/lit)
T_{6-C}	Gelatin + Bentonit + Silicasol	2(g/lit) + 6(g/lit) + 5(ml/lit)

[a]all treatments done in three replicate

Sensory and rheological analysis of GJC

(a) Sensory assessment test

To conduct sensory tests (color and flavor), twenty assessors among the experts of Nutrients Control Laboratory of Lorestan Province were chosen to analyze

the samples in terms of factors that are recognizable by senses, such as color and flavor with seven-point hedonic test[19].

(b) Rheological analysis

Viscosity of the samples was measured using a Brookfield viscometer (model DV-Iprime, American), spindle type (RV), flat, steel, No. 5, 100 r/min in 20ÚC and for 50 seconds[15].

(c) Statistical analysis

The design of experiment used was random complete blocks (factorial) with two factors (type and quantity of clarifiers) and three repetitions. Results were statistically analyzed, using the MSTAT-C software and ANOVA test. The medians were compared through LSD test at $p<0.05$.

RESULTS AND DISCUSSION

Effect of clarifying agent type on sensory and rheological properties

Analysis of grape juice

Analysis of grape juice samples for pH and acidity showed these parameters respectively equal to 3.56±0.01 and 0.59±0.01. The mean value for brix of grape juice samples was 23.1±0.37 which increased to 71.1–72.8 afted concentration using different clarifiers.

Sensory evaluation

Results of sensory evaluation for the color and flavor of different treatments are shown in TABLES 2 and 3. ANOVA test showed a significant difference between different treatments in terms of sensory tests of color and flavor ($P< 0.05$). Comparison of the medians of sensation assessment results indicates that among treatments employed GJCS as clarifier, the best sample in terms of color and flavor is the one clarified by 5% GJCS. According to the overall assessment of the samples, with an increase in GJCS, sensory characteristics like color and flavor are significantly improved. This may result from the creation of more transparency and reduction of pigments and phenolic compounds as a result of GJCS effect and its ability to absorb suspending and protein particles (blurring agents). GJCS is alkalic and contains considerable amount of calcium carbonate. Moreover, the soil neutralizes the acidity and increases the pH of grape juice[20]. Also in terms of flavor, the acidity of GJC in 3% GJCS treatment has earned less point from the panel group, which is confirmed by pH and acidity results of the samples. PH was measured by pH-meter (WTW 720, Germany) and total acidity was measured by titration method with NaOH 0.1N based on tartaric acid[11]. Overall, among different treatments, the lowest pH and the most acidity belong to GJCS treatment because of its alkaline nature (pH=8.5). While other filter-aid materials (bentonit, gelatin and silicasol) are chemically neutral (bentonit pH=7.3, gelatin pH=7.1 and silicasol pH=6.8) and therefore have no effect on the acidity and pH. As a result, in these treatments grape juice is neutralized with calcium carbonate. Results are in conformity with Basiri[4] and Zomorodi et al[19]. In treatments using only bentonit and silicasol, and also using gelatin-bentonit and gelatin-silicasol as clarifiers, the best sample in terms of color and flavor is the treatment that respectively employs 6% bentonit, 7% silicasol, 2% gelatin - 6% bentonit, 2% gelatin - 7% silicasol as clarifiers. Results are confirmed by the measures of transparency, turbidity and color to compare with sensory factor of color. To determine the color, transparency and turbidity, GJC is diluted up to 12 brix degrees with distilled water, and then the transparency and color of the samples were respectively determined by measuring the transmission of light in 625 nm and 440 nm wavelengths with spectrophotometer (Uv- Visible Varian, Australia) and turbidity was measured with turbidimeter (Wagtech, England)[19]. Also the measure of pH and acidity to compare with sensory factors of flavor. With ability the ability of surficial absorption and negative electrical charge, bentonit and silicasol can dramatically flocculate with positively charged compounds (blurring agents, pigments and phenolic compounds)[12]. Among treatments of gelatin- bentonit- silicasol compound used for clarification, the sample which is clarified with 2% gelatin - 6% bentonit - 5% silicasol and 2% gelatin - 5% bentonit - 6% silicasol is, without showing a significant difference, the best one in terms of color. This finding is also in conformity with the results from assessments with devices and chemical methods (To determine the color, transparency and turbidity). According results of these tests the most reduction of color intensity is for the treat-

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ment of gelatin- bentonit- silicasol. The reason is simultaneous use of various clarifiers and the resultant intensification of their effects on the elimination of phenolic compounds and pigments. Bodbodak et al.[6] studying different clarification treatments on physiochemical and rheological pomegranate juice showed that gelatin-bentonit- silicasol treatment with a reduction of 23%, has the least total anthocyanins among all treatments. No significant difference was detected in terms of flavor between treatments of gelatin – bentonit - silicasol of different densities. In terms of color, the panel group, without a significant difference preferred the treatments clarified with 2% gelatin - 6% bentonit - 5% silicasol, 2% gelatin - 5% bentonit - 6% silicasol, 2% gelatin - 7% silicasol, 2% gelatin - 6% bentonit and 6% bentonit over other treatments. The most undesirable samples in terms of general sensory assessment of color were of the treatments clarified with 3% GJCS and 5% silicasol. These results are in conformity with those obtained from assessments with devices and chemical methods. In terms of flavor, the panel group, preferred treatments clarified with 5% GJCS and 6% bentonit over other treatments. The most undesirable sample in terms of flavor was the one treated with 3% GJCS, because of its acidic, sour flavor. This is confirmed by pH and acidity test results.

TABLE 2 : Effect of type and quantity of clarifiers on color score

Treatments	Clarifier concentration		
	A	B	C
T_1	4.2 ± 0.6^{f}	5.1 ± 0.6^{de}	5.6 ± 0.4^{c}
T_2	4.9 ± 0.5^{e}	5.1 ± 0.5^{de}	6.7 ± 0.4^{a}
T_3	4.3 ± 0.4^{f}	4.9 ± 0.5^{e}	6.00 ± 0.6^{b}
T_4	5.3 ± 0.4^{d}	6.00 ± 0.5^{b}	6.6 ± 0.5^{a}
T_5	5.4 ± 0.6^{cd}	6.1 ± 0.5^{b}	6.7 ± 0.4^{a}
T_6	6.1 ± 0.5^{d}	6.6 ± 0.6^{a}	6.7 ± 0.4^{a}

Different letters on data differ significantly (P<0.05, n=3), Different treatments refer to TABLE 1

TABLE 3 : Effect of type and quantity of clarifiers on flavor score

Treatments	Clarifier concentration		
	A	B	C
T_1	4.6 ± 0.5^{e}	5.3 ± 0.8^{c}	6.2 ± 0.7^{a}
T_2	5.8 ± 0.5^{b}	5.8 ± 0.6^{ab}	6.2 ± 0.7^{a}
T_3	5.2 ± 0.4^{cd}	5.8 ± 0.5^{ab}	5.9 ± 0.6^{ab}
T_4	6.00 ± 0.6^{ab}	4.9 ± 0.5^{de}	5.8 ± 0.6^{ab}
T_5	5.2 ± 0.8^{cd}	6.2 ± 0.6^{ab}	5.8 ± 0.6^{b}
T_6	5.9 ± 0.6^{ab}	6.00 ± 0.7^{ab}	6.2 ± 0.7^{ab}

Different letters on data differ significantly (P<0.05, n=3), Different treatments refer to TABLE 1

Viscosity

Viscosity is a rheological characteristic of materials which is an important physical factor in quality control of fluid nutrients. In nutrition industry, awareness of the flux of concentrates is very useful and essential in order to control the quality, measuring the energy required, control of the process, and the choice of the equipment. GJC is normally condensed in open containers and in the traditional way. Nowadays, knowledge on the flux of materials is required to use modern technologies such as evaporating systems. Evaporating system type, transfer of nutrients, transfer speed of heath, and planning calculations for the industrial production line are all affected by the nutrient's viscosity[10]. Median of results for the viscosity in different treatments are displayed in table (4). ANOVA test showed a significant difference between different treatments in terms of viscosity ($P< 0.05$), in a way that bentonit treatment has the highest viscosity (257.3 cp) and gelatin-bentonit- silicasol treatment has the lowest (223.5 cp). Comparison of medians between different treatments indicates the highest viscosity for bentonit and silicasol treatment. This might be the result of the lack of effect on the part of bentonit and silicasol on the amount of pectin. Pectin is used to create viscosity, suspension in nutrient systems and specifically gelatin[8]. With regard to its role in viscosity, pectin adds to it when not eliminated from the environment (bentonit, silicasol and pectin are negatively charged). Treatments of gelatin-bentonit, gelatin- silicasol and gelatin- bentonit- silicasol show lower viscosity compared with treatments of sole bentonit and silicasol. This might be the result of using clarifiers such as gelatin in proximity with bentonit and silicasol. Positively charged gelatin has a considerable combination power with negatively charged pectin, which causes the pectin, and accordingly viscosity, to reduce. Results are in conformity with those of Bodbodak et al. (2009) regarding the clarification of pomegranate juice with clarifiers, and also with those of Rai et al.[13] regarding the clarification of Mosambi orange juice with classical methods.

TABLE 4 : Effect of type and quantity of clarifiers on viscosity content of GJC

Treatments	Clarifier concentration		
	A	B	C
T_1	240.2 ± 0.1^{g}	235.5 ± 0.1^{i}	246.5 ± 0.1^{f}
T_2	265.6 ± 0.1^{a}	256.6 ± 0.2^{c}	249.7 ± 0.2^{e}
T_3	256.4 ± 0.2^{c}	250.7 ± 0.2^{d}	262.4 ± 0.1^{b}
T_4	220.5 ± 0.1^{p}	234.5 ± 0.2^{j}	229.8 ± 0.1^{l}
T_5	237.3 ± 0.1^{h}	231.7 ± 0.2^{k}	223.4 ± 0.1^{o}
T_6	227.6 ± 0.1^{m}	224.4 ± 0.2^{n}	218.6 ± 0.2^{q}

Different letters on data differ significantly (P<0.05, n=3), Different treatments refer to TABLE 1

CONCLUSION

This research aims to study the effects of different clarification treatments on the produced GJC. Therefore, this program was executed to determine the best GJC clarification treatment and finally to determine the convenient method of GJC production. Results of statistical analysis showed that the treatment of gelatin-bentonit- silicasol has the lowest viscosity (223.5 cp) compared with other treatments. Moreover, the panel group gave a high score to this treatment as regards general sensory assessment of color and flavor.

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