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Effect of Inulin and Chitosan on the Quality of Cucumber Juice

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ABSTRACT

Objective: This study was carried out to produce highly nutrients juice from cucumber juice pre-treated with different concentrations of inulin and chitosan. Methods: cucumber juice pre-treated with different concentrations of inulin and chitosan were improved to a cucumber juice which was filling in previous sterilized glass bottles (200 ml capacity) at room temperature. Physico-chemical, pectinmethylesterase enzyme activity, color characteristics, viscosity, sugar profile (glucose, fructose and sucrose), mineral contents (K^+, Na^+, Ca, Cu, Fe, and Zn) and sensory evaluation of juice were evaluated. Results: minor changes in total soluble solids, pH, acidity and viscosity were seen. A remarkable improvement in sugar profile, minerals (K^+ , Na^+ , Ca, Cu, Fe, and Zn) and sensory evaluation was achieved with the increasing the concentration of inulin and chitosan in cucumber juice.

Conclusion: all quality characteristics especially Physico-chemical properties, viscosity, sugar profiles, mineral contents, color attributes and sensory evaluation tests showed that 1% inulin and 5%chitosan providing a good quality of juice as well as could be recommended for consumption as a nutrition juice. In future, it can be applied these results at industrial scale.

Word keys: cucumber, juice, inulin, chitosan, mineral, sugar.

Practical applications:
Today, consumers are more and more looking for juices which not only have better taste but also present benefits of health. The present study was conducted to determine the quality of cucumber juice which has been pre-treated with inulin and chitosan. The results of the study indicate that inulin and chitosan pre-treatments in clarified cucumber juice did not significantly affect its physicochemical, viscosity, color characteristics, sugar profiles, mineral contents and sensory characteristics. It also signifies the acceptability of clarified cucumber juice after pre-treatments with inulin and chitosan. The study can serve as a reference for food industry regarding quality stability of pre-treated clarified cucumber juice at different concentration of inulin and chitosan. In future, we could be applied these previous results as an inulin and chitosan treated cucumber juice at industrial scale.

Introduction

Modern proceed in bioscience back up the supposition that beyond providing nutrition, diet may modify various functions in the body that are pertinent to health. This has led to the notion of functional food." Any food is said to be "functional" if it contains a food component that affects one or many number of functions in the human body in a targeted method so as to have good and positive effects **[1].** Keeping in the view for this point, for over the world there is an increasing trend for the consumption and production of functional foods, especially the developed world. By the addition of phytochemical, bioactive peptides, and probiotics, we can be modified foods to become functional **[2].**

Inulin is the various functional food and natural food ingredients which commonly found in different percentages in nutritional foods. They are existent as plant stored carbohydrates in a number of plants and vegetables including onion, garlic, chicory, banana and wheat. In real, it

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was estimated that Europeans consume average 3–10 g/day but Americans consume on average 1–4 g of inulin per day **[3].** Inulin consumption had some hopeful health benefits such as increase absorption of calcium, stimulation of health benefit bacteria, like bifidobacteria and reduced caloric value because of the non-digestibility characteristics in the upper gastrointestinal-tract **[4].** Inulin is used as a neutral, as a clean flavor, to stability and acceptability of the low fat foods and to improve mouth feel. Also, Inulin is used to improve the sweetness and flavor of low calorie food and to modify foods with fiber without sharing in any harmful sensory effects. Inulin has nutritional properties and several functional which can be used to formulate innovative healthy foods for today's consumer **[5].**

Chitosan is obtained from the deacetylation of chitin, a natural oligosaccharide which is the major cell wall component for fungi and exoskeletons of insects and arthropods [**6]**. Is the most abundant organic material after cellulose. The antimicrobial activity of chitosan has been demonstrated against bacteria, yeasts and molds, with a broad spectrum of activity against Gram positive and Gram negative bacteria with low toxicity in mammalian cells **[7].** These properties make chitosan suitable for use as an additive in the processing of fruit juices. Can be used in the clarification process, with the reduction of turbidity [8, 9], reduction of acidity **[10],** reduction of browning **[11],** as antimicrobial agent **[12, 13],** antioxidant agent **[14]** and as a shelf life extender **[7].**

Cucumbers (Cucumis sativus L.), are a cool, refreshing summer treat when sliced and put in salads, marinated in vinegar, or eaten raw. Cucumber juice is the juice derived from cucumber produced by squeezing or pressing it. Cucumbers are 98% water, Low in calories and high in fiber and minerals, cucumbers are a safe addition to any diet. When it comes to vitamins, the most abundant one in cucumbers is vitamin K. Since vitamin K's primary role is to clot the blood. Cucumber contains vitamin K which found near the peel primarily, so cucumber peeling reduces the vitamin K amount we will consume and eliminate any pesticides that may be on the skin. Cucumber has a mineral content, including potassium, magnesium, and phosphorus. Potassium increases the excretion of Na, lowers rennin secretion, arteriolar vasodilatation, and lowers response to endogenous vasoconstrictor; while magnesium is a strong vasodilatation because it is lowering contractility of vascular smooth muscle. Therefore, health workers might need to promote the benefit of having cucumber juice to deal with hypertension in elderly with low price and affordable and without side effects **[15].** And lastly, refreshing and delicious cucumber vegetable is great for our kidneys protecting, due to its benefits as diuretic, but cucumber contains Cucurbitacins as a known unique compounds. In new trend, there is many research being worked on the benefits of like these compounds for treating cancer. The National Institutes of Health reports that it also plays a role in maintaining bone health. Also, cucumbers after peeled contain a good amount of vitamin C, with 3.8 mg containing (a one cup serving) which is 6 percent of the daily intake recommended **[16].** But during the seasons harvest, many quantities of cucumber fruit obtained spoiled due to excess production. Then, so a Long term preservation process is required that might be useful to prevent spoilage of cucumber fruits such that it might be consumed in other seasons as well. Keeping in view, the present study was conducted to process and develop clarified cucumber juice fortified with inulin and chitosan. Therefore, the present study was conducted to evaluate the effect of inulin and chitosan on the physicochemical, microbiological and sensory characteristics of clarified cucumber juice that has been fortified with inulin 1, 2 and 5% and chitosan at 5 and 10%, respectively. The objective was to determine the most suitable conditions for maintaining and improving cucumber juice quality.

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Materials and Methods

Chemical and Raw Materials

The fully matured, freshly harvested cucumber vegetable (Superstar cultivar) provided by the local market, Cairo, Egypt. Cucumber (*Cucumis sativus L.*) obtained from field experimental in institute of agronomy crops at Agricultural Research Institute, Giza, Egypt. Cucumber (*Cucumis sativus L.*) vegetable samples were used for all processing trials and was stored at 4 ^{o}C after receipt and processed within 24h.

Preparation and Extraction of Cucumber Juice

Sweet potatoes were washed, weighed and cut into smaller pieces and immersed into 1% sodium meta-bisulfite solution (SO_2). They were rinsed with water and homogenized with adding 1, 2, 5% inulin and 5, 10% chitosan using electric pulpier (blender). Cucumber juice was extract. The cucumber juice was then strained with double-layer cheesecloth. It filled the hot juice into clean, dry sterilized bottles hot. The bottled juice was cooled under running cold water and stored at room temperature for analysis (Figure-1).

Flow Chart for cucumber juice Preparation

Cucumber pieces peeled
↓
Immersed in 1% SO2
↓
Rinse with water
↓
Adding inulin (1, 2, 5%) and chitosan (5, 10%)
↓
Homogenized of Cucumber juice
↓
Cucumber juice extraction
↓
Strained with double-layer cheesecloth
↓
Packing (filled the hot juice into clean, dry sterilized bottles)
↓
Cooling, Capping and Storage (at temperature 24 0C) for analysis

Figure 1. Flow char or steps in the preparation and extraction of cucumber juice.

Physico-chemical Analyses

The pH of untreated and inulin or chitosan pre-treated cucumber juice samples was measured using a digital pH-meter (HANNA, HI 902 meter, Germany). The percent of Total Soluble Solids (TSS), expressed as oBrix (0-32), was determined with a Hand refractometer (ATAGO, Japan). Titratable acidity of juice samples was determined according to the method reported by **Tung-Sun [17]**.

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Sedimentation Measurement

Sedimentation was measured by the method of **Krop and Pilnik [18]** 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.

Viscosity Measurements

The viscosity measurements were carried out using a viscometers (VISCO:Cp, Brokfield, DV-111 Ultra, Made in USA) with thermostatic bath to control the working temperature 17.5oC. The test sample (100ml) was heated to the desired temperature in water bath (accuracy +0.5), then transferred into measuring bowl, which was surrounding by temperature regulating vessel with spindle 3 and 250rpm. Results of viscosity were expressed in (cP) according to the method of **Ibarz, [19].**

Pectin methyl esterase (PME) Enzyme Activity Determination

Pectinmethylesterase enzyme (EC 3.1.1.11) (PME) activity was measured titrimetrically by determining free carboxyl groups formed as a result of enzyme action on pectin. The reaction mixture was composed of 15 mL of 0.25% citrus–pectin solution, 0.15 M NaCl; 0.5 mL of enzyme sample and the final volume was adjusted to 30 mL with distilled water. The volume of 0.1 M NaOH required to maintain the reaction mixture at pH 8.0 (30 ± 2oC) was measured using the method described by **Kertesz [20], Arreola, [21] and Amaral [22]** . One unit of PME was defined as the amount of enzyme which released 1 m mol of carboxyl groups/min. Experiments were conducted in triplicate. PME activity (units) was calculated by using the following formula **[23]:**

$$\text{PME} = \text{units/mL} = \frac{(\text{mL NaOH})(\text{Molarity of NaOH})(1000)}{(\text{time})(\text{mL sample})}$$

Sugars Determination

The total, reducing and non-reducing sugars in cucumber juices under investigation were determined by the official Lane-Eynone titrimetric method as described in A.O.A.C. [24]. The sample was clarified by lead acetate and excess of lead acetate was precipitated by sodium oxalate. The reducing sugars and total sugars were determined in the clarified solution applying the official Lane-Eynone titrimetric method and the non-reducing sugars were calculated from the difference between the percentage of reducing and total sugar.

Colour Characteristics

Colour of untreated and inulin or chitosan pre-treated cucumber juice was measured using spectro-colourimeter (Tristimulus Colour Machine) with the CIE lab colour scale (International Commission on Illumination) as mentioned by Sapers and Douglas [25] and Hunter [26]. Colour of samples was measured using a HunterLab colourimeter Hunter a*, b* and L*. Parameters were measured with a colour difference meter using a spectro-colourimeter (Tristimulus Colour Machine) with the CIE lab colour scale (Hunter, Lab Scan XE - Reston VA, USA) in the reflection mode. The instrument was standardized each time with white tile of Hunter Lab Colour Standard (LX No.16379): X= 72.26, Y= 81.94 and Z= 88.14 (L*= 92.46; a*= -0.86; b*= -0.16). The instrument (65°/0° geometry, D25 optical sensor, 10° observer) was calibrated using white and black reference tiles. The colour values were expressed as L* (lightness or brightness/

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darkness), a* (redness/greenness) and b* (yellowness/blueness). The Hue (H)*, Chroma (C)* and Browning Index (BI) was calculated according to the method of Palou et al., [27] as follows:

H* = tan-1 [b*/a*]…………….….………………….…(1)

C* = square root of [a2* + b2*]....………….......……...(2)

BI = [100 (x-0.31)] 10.72……….………….……….…(3)

Where:- X = (a*+ 1.75L*) / (5.645L*+ a* - 3.012b*)

Δ E = (Δ a2+ Δ b2 + Δ L2) 1/2 ……….….………..……(4)

Where, all values were recorded as the mean of triplicate readings.

Mineral Determination

Sodium, potassium, iron, zinc and copper contents of fresh and inulin or chitosan-treated cucumber juice samples were determined in the digested solution according to the method described by **Jackson [28].** Mineral content (iron Fe, copper Cu, sodium Na, potassium K and zinc Zn) of fresh and inulin or chitosan-treated cucumber juice was determined using a Unicom SP 1900 atomic absorption spectrophotometer (FMD3) according to the method of A.O.A.C. **[29].**

Sensory Evaluation

The panel was composed of twelve panelists and staff from the Department of Food Technology at National Research Centre. Eleven training sessions were held prior to the test where panelists collaboratively developed aroma and flavor descriptors and standards. Colour, flavour, taste, acceptance and appearance of the untreated and inulin or chitosan pre-treated cucumber juice samples were determined using a ten point scale (10 = excellent and 1 = bad) as described by **García et al., [30] and Bertolini et al., [31].** The limit of the acceptability was 5. Samples were served in a randomized complete block design with all panellists evaluating all samples at one sitting. Sample order presentation was randomized. Four replications were completed.

Statistical Analysis

The obtained results were analyzed statistically using the analysis of variance (ANOVA with two ways) and the Least Significant Difference (LSD) as described by **Richard and Gouri, [32]**.

Results and Discussions

Effect of inulin and chitosan on physico-chemical properties of cucumber juice

The pre- treatment with inulin increased the Total Soluble Solids ºBrix (TSS) from 3.5 to 5.2 ºBrix with the concentration of inulin, but chitosan increased the Total Soluble Solids ºBrix (TSS) from 3.0 to 3.2 ºBrix with the concentration of chitosan compared to control without inulin and chitosan of cucumber juice 3.0 ºBrix, as shown in Table 1. The increasing of TSS with the addition of inulin or chitosan can be explained by the ability of this positively charged polymer coagulate the suspend solids through binding to the positively charged sugars **[7, 11].**

The pH of inulin pre-treated cucumber juice increased with the concentration of inulin from 6.28 to 6.34, but chitosan pre-treated cucumber juice did not change with increasing the increasing concentration of chitosan 6.36 compared to untreated cucumber juice 6.2, as shown in Table 1. The increase of pH and stability of juice during processing can be due the ability of inulin and

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chitosan to reduce acidity **[10],** which confirms the reduction of acidity evidenced in this study compared with untreated cucumber juice. This effect was explained by the ability of inulin and chitosan, positively charged at low pH, binding to acids, negatively charged **[33].**

Whereas, results indicated that the titratable acidity as a malic acid (%) of inulin pre-treated cucumber juice decreased with the increasing concentration of inulin from 0.129 to 0.114, but chitosan pre-treated cucumber juice decreased with increasing the concentration of chitosan from 0.116 to 0.114 compared to untreated cucumber juice 0.167, as shown in Table 1.

TSS/acidiy ratio of inulin pre-treated cucumber juice decreased with the increasing concentration of inulin from 27.13 to 45.61 compared to untreated cucumber juice 17.96, but chitosan pre-treated cucumber juice decreased with increasing the concentration of chitosan from 28.30 to 28.07, as shown in Table 1.

The main analytical measurement for cucumber juice quality is the TSS / acidity ratio. The larger TSS / acidityratio leads to the flavor the better of the juice **[17].** It was higher in inulin treated cucumber juice (27.13 to 45.61) and in chitosan treated cucumber juice (28.30 to 28.07) compared to untreated cucumber juice (17.96).

This indicates that inulin and chitosan pre-treated juice may be suitable for fresh using. However, it could be treated into good quality cucumber juice. **Fellers et al. [34]** found that grapefruit juice with TSS / acidity ratios above 11.0 had higher consumer preference scores than juice with TSS / acidity ratios 7.0. They also reported that the total soluble solids (Brix), total acidity and pH of juice were unchanged. **Sohail et al., [35]** found that the pH, TSS and acidity contents can be recommended for production of high value-added and processed products such as cucumber juice fortified with inulin and chitosan.

No sedimentation occurred and no pectinmethylesterase (PME) was detected in the inulin and chitosan treated of cucumber juice as compared to the untreated cucumber juice (30%) and (0.333 unit/mL), respectively, as seen in table 1. The PME activity was inhibited by heating, as seen in extraction and processing with inulin and chitosan of cucumber juice.

Table 1. Effect of inulin and chitosan on physico-chemical properties of cucumber juice.

	TSS	**pH**	**T. acidity**	**TSS/acidiy ratio**	**PME- activity (unit/ml)**	**Sedimentation (%)**
Control	3.0	6.2	0.167	17.96	0.333	30.0
inulin 1%	3.5	6.28	0.129	27.13	0.00	0.00
inulin 2%	4.0	6.28	0.129	31.00	0.00	0.00
inulin 5%	5.2	6.34	0.114	45.61	0.00	0.00
Chitosan 5%	3.0	6.36	0.116	28.30	0.00	0.00
Chitosan 10%	3.2	6.36	0.114	28.07	0.00	0.00

Effect of inulin and chitosan on colour characteristics and parameters of cucumber juice

In the present study, color of the cucumber juice in terms of 'L*' (lightness), 'a*' (redness) and 'b*' (yellowness), ΔE, A_{420nm}, C* (chroma), H* (Hue angle) and BI (Browning index) values were 34.29, -11.06, 22.22, 54.81, 2.86, 24.820, 62.55 and 21.546, respectively measured, as seen in

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table 2. The values found for the parameter a* (redness) ranging from -10.46 to -11.58, the b* (yellowness) 21.06 to 26.79 and the L* (lightness) 33.08 to 60.22, as seen in table 2. The chromatic characteristics of cucumber juice showed negative and positive values of a * and b *, i.e., the colors red and yellow, respectively, are related to the carotenoids. However, it appears that the intensity of the yellow component b * is greater than the red component a *, revealing that the juice had an orange coloration.

L*, b*, C* and H* values were increased with increasing of inulin concentration and decreased with increased of chitosan concentration in pretreated cucumber juice compared with untreated cucumber juice samples. But ΔE is opposite trend compared with untreated cucumber juice samples. The increase in luminosity L* occurred due to the fining properties of chitosan. The reduction of L*, b*, C*, H* and BI are during chitosan pretreatment cucumber juice according to **Martín-Diana [7]** that assigned this effect to the settling unstable particles of juice and the loss carotenoid pigments.

Knorr (1983) in turn suggests that the chitosan is capable of binding to stains, which is consistent with the results shown in this study. The reduction in L*, b*, C*, H* and BI values with the addition of chitosan is mainly due to its ability to sequester carotenoids **[7].**

A_{420nm} values were increased with increasing of inulin concentration and decreased with increased of chitosan concentration in pretreated cucumber juice compared with untreated cucumber juice samples. The increasing of this parameter is associated with increased non-enzymatic browning, which is consistent with the increased potential for browning observed in the present study.

Results indicated that the chromatic characteristics of cucumber juice showed negative values of a* (redness) in all inulin and chitosan pretreatments. We suggested the control of browning of all inulin and chitosan treated could be related with the ability to coagulate solids to which browning associated enzymes are bound. The ability related with phenolic compounds, similar to the antioxidant ability of chitosan, could also demonstrate this browning reduction by the inhibition of oxidative process. **Abd and Niamah [36]** found that it was strong relationship between inhibition of browning and chitosan concentration.

Table 2. Effect of inulin and chitosan on colour characteristics of cucumber juice.

	L*	**a***	**b***	**ΔE**	**A_{420nm}**	**C***	**H^*_{tan-1}**	**BI**
Control	34.29	-11.06	22.22	54.81	2.86	24.820	63.55	21.546
inulin 1%	41.31	-11.25	24.93	50.22	4.27	27.350	65.71	24.917
inulin 2%	47.57	-11.58	25.8	46.47	6.04	27.840	66.62	24.595
inulin 5%	60.22	-10.46	26.79	36.91	12.82	29.186	67.93	21.692
Chitosan 5%	34.36	-11.41	22.32	54.85	2.88	25.067	62.92	20.31
Chitosan 10%	33.08	-11.04	21.06	55.75	2.76	23.778	62.34	18.789

Effect of inulin and chitosan on glucose, fructose and sucrose content (mg/ml) of cucumber juice

The determination of sugar profile in commonly consumed untreated, inulin and chitosan treated cucumber juice samples were achieved using HPLC (high performance liquid chromatography).

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The content of glucose was found lower than the content of fructose in many of untreated, inulin and chitosan treated cucumber juice samples, as seen in table 3. The same results were confirmed by **Şana and Yusuf [37].**

The results of glucose, fructose and sucrose content (mg/ml) is given in table 3. Table (3) is summarized the sugar profiles of the examined cucumber juice samples. The results obtained have shown that the glucose and fructose were the major component of total sugar in cucumber juice. But the sucrose contents in all of the examined samples were not detected.

The mean fructose and glucose levels in cucumber juice were higher with increasing inulin concentration compared with untreated cucumber juice, as shown in table 3. The glucose content increase from 5.66 mg/ml in untreated juice to 8.65 mg/ml in 5% inulin. Also, the fructose content increase from 5.91 mg/ml in untreated juice to 9.27 mg/ml in 5% inulin. The content of total sugar in juices is essentially made up of glucose, fructose, and sucrose (saccharose). Under the applied HPLC conditions, contents of glucose and fructose were 5.66 and 5.91mg/ml in untreated cucumber juice respectively by HPLC, glucose (Gl): fructose (Fr) ratios were 0.96, while according to the HPLC determination; there is no sucrose in the cucumber juice, as shown in Table (3). Results indicated that the glucose (Gl): fructose (Fr) ratios were decreased from 1.04 to 0.93 by increasing inulin concentration, but it was constant (0.98) by increasing chitosan concentration, as seen in table 3. The determine of sucrose, glucose and fructose contents, as well as glucose: fructose ratio was necessary for sugar profiles of cucumber juice.

In the end of point, no previous data and research linked to sugar profiles of cucumber juices. The important interesting of this study was the first alone study in the research literature for the sugar profiles determination of cucumber juices.

Table 3. Effect of inulin and chitosan on glucose, fructose and sucrose content (mg/ml) of cucumber juice

	Glucose (mg/ml)	**Fructose (mg/ml)**	**Gl : Fr Ratio**	**Sucrose (mg/ml)**
Control	5.66	5.91	0.96	0
inulin 1%	7.63	7.35	1.04	0
inulin 2%	7.62	7.79	0.98	0
inulin 5%	8.65	9.27	0.93	0
Chitosan 5%	4.25	4.33	0.98	0
Chitosan 10%	5.73	5.86	0.98	0

Effect of inulin and chitosan on viscosity (cP) of cucumber juice:
The viscosity values of untreated was 13.8cP and pretreated with inulin and chitosan of cucumber juice ranged from 13.8cP to 15.4cP (Table 4), Adding chitosan with 5 and 10% in the form of gel increased viscosity of the cucumber juice from 15.2cP to 15.4cP. On the other hand, the viscosity increased by increasing insulin concentration from 13.8 to 15.8cP, as seen in table 4. This is mainly due to degradation of pectin, resulting in a reduced capacity for water retention and release of free water to the system [38,39].

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Table 4. Effect of inulin and chitosan on viscosity (cP) of cucumber juice

	Viscosity (cP)
Control	13.8 ±0.05
inulin 1%	13.8 ±0.07
inulin 2%	14.2 ±0.04
inulin 5%	15.8 ±0.09
Chitosan 5%	15.2 ±0.06
Chitosan 10%	15.4 ±0.11

Effect of inulin and chitosan on mineral contents (mg/100 g or %) of cucumber juice

The mineral analysis was achieved using standard new laboratory technique; mineral content for K+, Na+, Ca, Cu, Fe, and Zn was analysed in cucumber juice using the Atomic Absorption spectrophotometer technique.

Mineral composition of untreated, inulin and chitosan pretreatment of cucumber juice (per 100ml) was given in Table (5). Fresh or untreated cucumber juice have a potassium, calcium, sodium, iron, zinc and copper content of 0.19, 0.05, 0.215, 0.208, 15 and 1.2 mg/100 g or %., respectively.

The result of the mineral analysis showed (table 5) that inulin and chitosan treated cucumber juice samples had the highest value in Ca, Na, zn and cu content and had the lowest value in Fe iron content compared with untreated cucumber juice (control sample), but had the same value (0.19 mg/100 g or %) in K potassium content with untreated cucumber juice (control sample). The result revealed that different inulin and chitosan treated cucumber juice differ in the content of mineral. This that could reflect on the cucumber nutritional quality. However, mineral content in untreated, inulin and chitosan pre-treatment of cucumber juice (mg per 100ml) showed that the previous data obtained was high cucumber nutritional quality, because the nutritional value of the cucumber juice obtained are into the United State standard good quality of cucumber juice **[40].**

Table 5. Effect of inulin and chitosan on mineral contents (mg/100 g or %) of cucumber juice.

	Control	**inulin 1%**	**inulin 2%**	**inulin 5%**	**Chitosan 5%**	**Chitosan 10%**
K	0.19	0.19	0.19	0.19	0.19	0.19
Ca	0.05	0.18	0.28	0.33	0.09	0.012
Na	215	215	219	225	215	225
Fe	208	166	175	186	172	131
Zn	15	18	16	14	20	22
Cu	1.2	1.6	1.8	1.9	1.7	1.8

Sensory analysis:

The concentration of inulin and chitosan significantly affected the sensory acceptance of cucumber juice (Table 6). The sensory scores ranged from 6.2 to 8.6.

The overall assessment at zero time showed a significant reduction in sensory acceptance from 7.2 in control sample but with the addition of 5% inulin and 10% chitosan to 6.2. Also, the overall assessment at zero time showed a significant reduction in sensory color from 8.6 in

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control sample but with the addition of 5% inulin to 6.8 and with 10% chitosan to 8. The overall assessment at zero time showed a significant reduction in sensory flavor from 8.3 in control sample but with the addition of 5% inulin to 7 and with 10% chitosan to 7.2. Results showed that the better sensory scores were (7.8, 7.5, 8, 7.6 and 6.8) in 1% inulin pre-treated sample compared with sensory scores (7.8, 8.3, 8.6, 7.8 and 7.2) in control sample, as seen in table 6. Therefore, after the processing initialize (time 0), the cucumber juice was given the highest scores sensory (Table 6) which are however reduced by the addition of inulin (1, 2 and 5%) chitosan (5 and 10%). These results are in agreement with Martín-Diana [7] who found a reduction in the overall assessment of the juice with the addition of chitosan. This is due to the bitter taste of the juice due to the addition of chitosan gel **[41].**

Throughout the store there was a reduction of notes sensory acceptance. In 1% inulin, however, attributes for taste, flavor, color, texture and acceptance assessment there was reduction. These results corroborate **Freitas et al [42]** who observed a reduction in the acceptance of color and flavor in addition to reducing the taste and acceptance assessment of the note at the end of shelf life of acerola juice.

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The juices added chitosan were acceptable compared to the control, being in agreement with **Martín-Diana [7].**

Table 6. Effect of inulin and chitosan on sensory evaluations of cucumber juice.

	taste	**Flavor**	**Colour**	**texture**	**acceptance**
Control	7.8[a]	8.3[a]	8.6[a]	7.8[a]	7.2[a]
inulin 1%	7.8[a]	7.5[b]	8[b]	7.6[b]	6.8[b]
inulin 2%	7.4[c]	7.2[c]	7[c]	7.6[b]	6.6[c]
inulin 5%	7.2[d]	7[d]	6.8[d]	7.4[c]	6.2[d]
Chitosan 5%	7.6[b]	7.4[b]	8[b]	7.4[c]	6.6[c]
Chitosan 10%	7.2[d]	7.2[c]	8[b]	7.2[d]	6.2[d]

* Data is expressed as means *Values followed by different upper case or lower case letters are significantly different ($p \leq 0.05$) within columns and rows respectively.

Conclusion

It was concluded that the cucumber juice pre-treated with inulin and chitosan was larger effective juice for maximum rich in pH, TSS, TSS/acidity ratio, sedimentation, pectinmethylesterase enzyme activity, color characteristics, viscosity, sugar profile (glucose, fructose and sucrose), mineral contents (K^+ , Na^+ , Ca, Cu, Fe, and Zn) and sensory evaluation. Sensory evaluation of inulin and chitosan treated cucumber juice was had well and better acceptability score and likely to satisfy taste of consumer and his preferences. Therefore, we can be recommended a fresh and good quality of cucumber juice which pre-treated with inulin and chitosan for consumption. Also, inulin and chitosan pre-treated cucumber juice could be used for enucleate the problems of malnutrition in developing and under developed countries like Egypt, because that cucumber juice a source cheap complete nutrition. In future, we could be applied these previous results as an inulin and chitosan treated cucumber juice at industrial scale.

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