CAFEi2012-15

PHYSICOCHEMICAL PROPERTIES OF JOSAPINE PINEAPPLE (*ANANAS COMOSUS*)

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ABSTRACT

Pineapple pulp and its freeze-dried powder prepared from Josapine pineapple were assessed for physicochemical properties such as colour values (L*, a*, and b*), titratable acidity (TA), total soluble solids (TSS), proximate composition (moisture, protein, ash, fiber and fat content), water activity (Aw), pH, and also the sensory evaluation. Data obtained were analysed using ANOVA where the values of $p<0.05$ were define as significant. Moisture content, TSS and colour measurement showed a significant different p(<0.05) where; moisture content (pulp) in the range of 87.90 – 91.17 %, moisture content (powder); 1.98 – 2.92 %; TSS (pulp): 18.74 – 22.81 °Brix, TSS (powder): 31.76 – 35.30 °Brix; colour measurement (pulp): L* (51.11-75.27), a* (3.35-3.93), colour measurement (powder): L* (37.59 – 49.63), a* (2.91 – 6.47). All the range of values is throughout all the treatments which can be used to discriminate between pulp and freeze-dried powder, whilst TA, TSS, pH and sensory evaluation results can be used to discriminate between freeze-dried powders prepared using maltodextrin and the one with addition of sugar.

Keyword*: *Josapine pineapple, physicochemical analysis, proximate composition, freeze-dried pineapple powder

INTRODUCTION

Pineapple is the most important representative of the Bromeliaceae family and is cultivated in tropical and subtropical countries including Malaysia, Hawaii, South Africa, Philippines and Thailand for local consumption and also international export [1]. Based on its potential economics and commercial value, pineapple has been identified as one of the priority commodities to be developed for the domestic and international markets in The Third of National Agriculture Policy – NAP 3[2]. Malaysian pineapple varieties include Moris, Gandol (N19), Sarawak, Josapine and Maspine. Among them Josapine used in this study is a popular variety in Malaysia. Josapine is an acronym for the hybrid of the '***Jo*hor**' (Spanish) and '***Sa*rawak**' (Cayenne) '***Pine*apple**' and this hybrid was officially released by MARDI on 5 August 1996 [3] and it had been commercialized successfully.

Ananas comosus is a delicious and popular fruit due to its good aroma, flavour, juiciness, sweetness and texture. It is also a very nutritious as it is a good source of vitamin A and C, fiber and also minerals [4]. All this tremendous quality of the pineapple contributes in the well acceptance of this fruit to the people worldwide. Analysis of a freshly harvested pineapple fruit has revealed that the freshly harvested pineapple fruit contains 80-85% water, 12-15% sugar (two-thirds is sucrose and the rest is the nearly equivalent amount of glucose and fructose), 0.6% acid (87% citric acid and the rest is malic acid), 0.4% protein, 0.5% ash, 0.1% fat, small amount of fiber and several vitamins (mainly vitamin A and C) [5]. Besides vitamin C, pineapple contained an appreciable amount of insoluble fiber-rich fraction (41.8-48.0 g/100g) which suggested that the pineapple have an excellent potential in food application as a functional ingredient for reduction of calories and dietary fiber enrichment [6].

Pineapple is mainly consumed fresh and a big part has been processed. Among the processing, canning is the major processing techniques practised in the major pineapple producing country. Currently pineapple juice or concentrates are processed into powder for making it more convenient during consumption, storage and transportation. For powdering of pineapple juice or concentrate, spray drying method is used commercially with added carrier agents like maltodextrin. Additives are incorporated mainly to reduce the hygroscopicity of powder and also to prevent caking. Literatures report many research on the physicochemical properties of spray dried pineapple powder. However, the research concerning the comparative study of the physicochemical properties of pineapple pulp and freeze dried powder as affected by the added additives is scare. The objective of this study was to investigate the physicochemical properties including the proximate analysis, colour, antioxidant properties and other quality attributes of the Josapine pineapple pulp and powder with respect to different treatments using maltodextrin and sugar.

MATERIAL AND METHODS

Fruit pulp preparation

Fresh pineapple fruits of the Josapine variety were purchased from Pasar Borong Selangor, Malayisa. Fully mature, ripe, attractive bright orange red were picked in batches of five for the appropriate laboratory determinations. After purchased, the fruits were transported immediately to the laboratory. For the maximum sanitizing effect prior to processing, the working area, cutting board, knife, plastic containers and other utensils used were washed and sanitized with sodium hypochlorite solution at pH 7. After the removal of the crown and skin, the whole were crushed into pulp using a domestic blender. The pulp then was put into airtight plastic container and kept in the freezer (-20°C) for further preparations and analysis.

Fruit powder preparation

The pineapple pulp was prepared in several containers and added with 10 % maltodextrin, 20 % maltodextrin, 10 % sugar, and 20 % sugar separately, Corn maltodextrin DE 10 (food grade) was used and as for the sugar, combination of 9 % sucrose, 3 % fructose and 3 % glucose are adapted to the treatments. Then, the prepared pulp was frozen in plastic containers for 5h at -20°C. After freezing, the samples were transferred to a vacuum freeze dryer (Ben Hay, United Kingdom) and dried at -35 °C for 48h at 0.25 millibars pressure. The pineapple powder was obtained by crushed the dried material in a sealed plastic and stored in a refrigerator (4°C) until further tests were carried out.

Colour measurement

The instrumental measurement of samples, pineapple pulp and powder was carried out using a Colorimeter Minolta CM-3500d (Minolta Spectrophotometer, USA). The results were presented in accordance with the CIELAB system. The measurements were performed using a 6.4 mm diameter diaphragm with an optical glass where the samples were poured directly in the optical glass. The parameters obtained were L* represents the brightness of the colour (L* = 0 [black], L* = 100 [white]), a* (-a = greenness, +a = redness) and b* (-b = blueness, +b = yellowness). The average of three replicates for L*, a* and b* were recorded.

Titratable acidity (TA)

Sample were weighed for 10 g and mixed with 200 ml of distilled water, boiled for one hour. Then the mixture was cool before filter. 10 ml of filtrate was titrated with 0.1M NaOH up to pH 8.1 using automatic titratable machine [7].The total acidity can be calculated and expressed as % citric acid (% c.a.) (g citric acid / 100 g fresh-weight). The average of three replicates for titratable acidity was recorded.

Proximate analysis

The proximate analysis was carried out on the pineapple pulp and powder. The proximate analysis consists of moisture content, ash, protein, fat, fiber and carbohydrate. Moisture content was measured using oven method according to standard method. Ash content was determined using standard method where 5 g of sample was kept in the muffle furnace and ashed at a maximum temperature (525°C) for 6 h. Next, the ash cooled in a dessicator and weighed. [8]. Protein was determined using Kjeldahl method while Soxhlet method was used for the fat determination. The determination of fiber was adapted from method of using sulphuric acid followed by sodium hydroxide [7] Total carbohydrate content of sample was calculated by the difference of the total weight of the sample (100%) and summation of other constituent (protein, fat, moisture content, ash and fiber) [9]. All proximate analysis was done in triplicate and the average reading performed with the standard deviation.

pH, total soluble solid (TSS), water activity (A_W)

pH of the sample was measured using pH metre (Mettler Toledo, Switzerland), In addition, for pineapple powder sample, 8% (w/v) powder suspension was prepared and stirred for 5 min, allowed to stand for 30 min, then the powder suspension was filtered and pH of the filtrate measured [10]. Using the same suspension for the powder sample, the total soluble solids (TSS) was measured using a refractometer (Atago PAL-1, Japan) [11]. In case of pulp sample, the TSS value can be obtained directly using the refractometer [10]. Water activity for the samples can be determined by using digital A_w meter (Model 3TE, Aqualab, WA). For all the analysis, the average value of triplicated samples was reported.

Sensory analysis

The samples are coded with random letters. The freeze-dried powders were dissolved in 50 ml water. Thirty panellist aged between 19 to 48 years, able to differentiate and evaluate the Josapine pineapple pulp juice and freeze-dried powder samples, were selected to take part in the sensory panel. The panel measured the selected critical attributes such as aroma, flavour, colour, sweetness and total acceptability. Josapine pineapple freeze-dried powder drink were prepared and compared with those prepared from the pulp. The 2.5g freeze-dried powder was dissolved into the 50 ml water. All the sensory panellists have to tastes Josapine pineapple drink and then gave higher scores for the taste for each sample. Scores assigned for each sensory attributes were sum up to obtained the total acceptability. The panellists were given an evaluation form where they have to taste one sample at a time and record their response.

Visual assessment of caking

Visual assessment of the powder caking was carried out for freeze-dried powders after exposure to atmosphere at room temperature (26 °C). The powder at different treatments was places in steel tray and was exposed for the specified exposure time. The powder was spread till form a thin layer of about 1 cm thick to increase the rate of water sorption, After the exposure time, the steel tray were visually inspected for caking behaviour by moving the spatula through the powder or cake and assessed if the powder had caked or not and if had caked, the cake was a soft cake, strong cake or hard cake.

Statistical analysis

All the analysis was conducted in three replications. One–way analysis of variance (ANOVA) was adapted to compare the experimental analysis. Differences among the analysis mean were determine using Least Significant Different (LSD) test. Values of $p<0.05$ were define as significant. All the statistical analysis were conducted using the Statistical Analysis Software (SAS) Version 7.2 [12].

RESULTS AND DISCUSSIONS

Color measurement

Color is the most obvious attributes that occurs in many fruits and it is the main characteristic for the consumers to evaluate the quality of the fruits. Generally, natural colourants are unstable and colour of fruits and fruit products may change during processing and storage. The lightness (L*) and yellowness (b*) are the major colour parameters for quality determination of pineapple processing [13]. Table 1 shows the value of L*, a* and b* of Josapine pineapple pulp and freeze-dried powder. An increase in L* and b* values was observed following the production of freeze-dried powder from the pulp, which resulted in darker yellow product. The reason behind the phenomenon was probably due to the non-enzymatic browning or Maillard reaction occured during freeze drying process. Pineapple contains glucose, fructose and amino acids which fulfilling the prerequisites for non-enzymatic browning during processing. This is in agreement with the result of Moβhammer et al. [14] where they obtained a slightly darker cactus pear freeze-dried powder from drying of cactus pear concentrates. Cactus pear is rich with glucose, fructose and also amino acids especially proline which give result for non-enzymatic browning during the drying processing. Chopda and Barrett [15] also stated that the result of the darker guava puree powder after the freeze drying process due to the effect of non-enzymatic browning. However, it could be recommended that the freeze drying process have the ability to improve colour of the product after processing compared to other drying methods [16]. There were significant differences ($p<0.05$) between L* and a* values for powders prepared using maltodextrin combination. Increasing of L* value and decreasing of a* value for pineapple treatment with maltodextrin result in change of colour. The colour of the freeze-dried pineapple powder becomes light after drying process. Chopda and Barrett [15] reported the production of the bright white guava powder after freeze drying of the guava puree with maltodextrin. Increase in L* value and decrease in a* value were reported during freeze drying process due to the oxidation of pigments increasingly exposed the white colour of maltodextrin.

Table 1: Change in L*, a* and b* of Josapine Pineapple Pulp and Freeze-dried Powder at Different Treatments

Treatments	Hunter Colour Values					
	L*		a*		b*	
	Pulp	Powder	Pulp	Powder	Pulp	Powder
1. Pure	37.59±0.03	52.37±0.04	3.47±0.04	6.46±0.02	23.86±0.04	37.64±0.04
2. Pure + Maltodextrin 10%	49.62±0.03	74.19±0.06	3.89±0.01	2.91±0.02	24.13±0.02	38.37±0.02
3. Pure + Maltodextrin 20%	49.59±0.03	75.27±0.12	3.93±0.02	2.98±0.01	24.17±0.01	37.97±0.01
4. Pure + Sugar 10%	46.11±0.03	52.19±0.57	3.40±0.03	6.47±0.02	23.60±0.10	36.62±0.04
5. Pure + Sugar 20%	46.02±0.01	51.11±0.01	3.35±0.01	6.32±0.05	23.50±0.01	37.09±0.02

Data represents mean ± SD of triplicate analysis

Titratable acidity (TA) and total soluble solids (TSS)

The titratable acidity (TA) for the Josapine pineapple pulp at different treatments ranged from 0.60 to 0.69 % c.a. and from 0.54 to 0.66 % c.a. for powder at different treatments, respectively (Figure 1). TA values for pure pulp were lower than that of reported for Valencia oranges by Chen et al. [17] and slightly higher than the one that reported by MARDI [3]. There is no significant ($p<0.05$) different of TA but there is a significant ($p<0.05$) increase of TSS after drying of Josapine pineapple pulp. The loss of acids might be the reason of the reduction of some acidity [18]. Askar et al. [19] reported a significant loss of the TA after freeze drying of guava puree. From the figure, the increase in TSS after freeze drying process may be the result of the concentration of the soluble solids. A decrease in acidity and an increase in TSS are the important parameters in flavour development [20]. Furthermore, the sugar-acid ratio has been used as a maturity index and found to increase with ripening of fruits [21].

e-ISBN 978-967-960-322-4

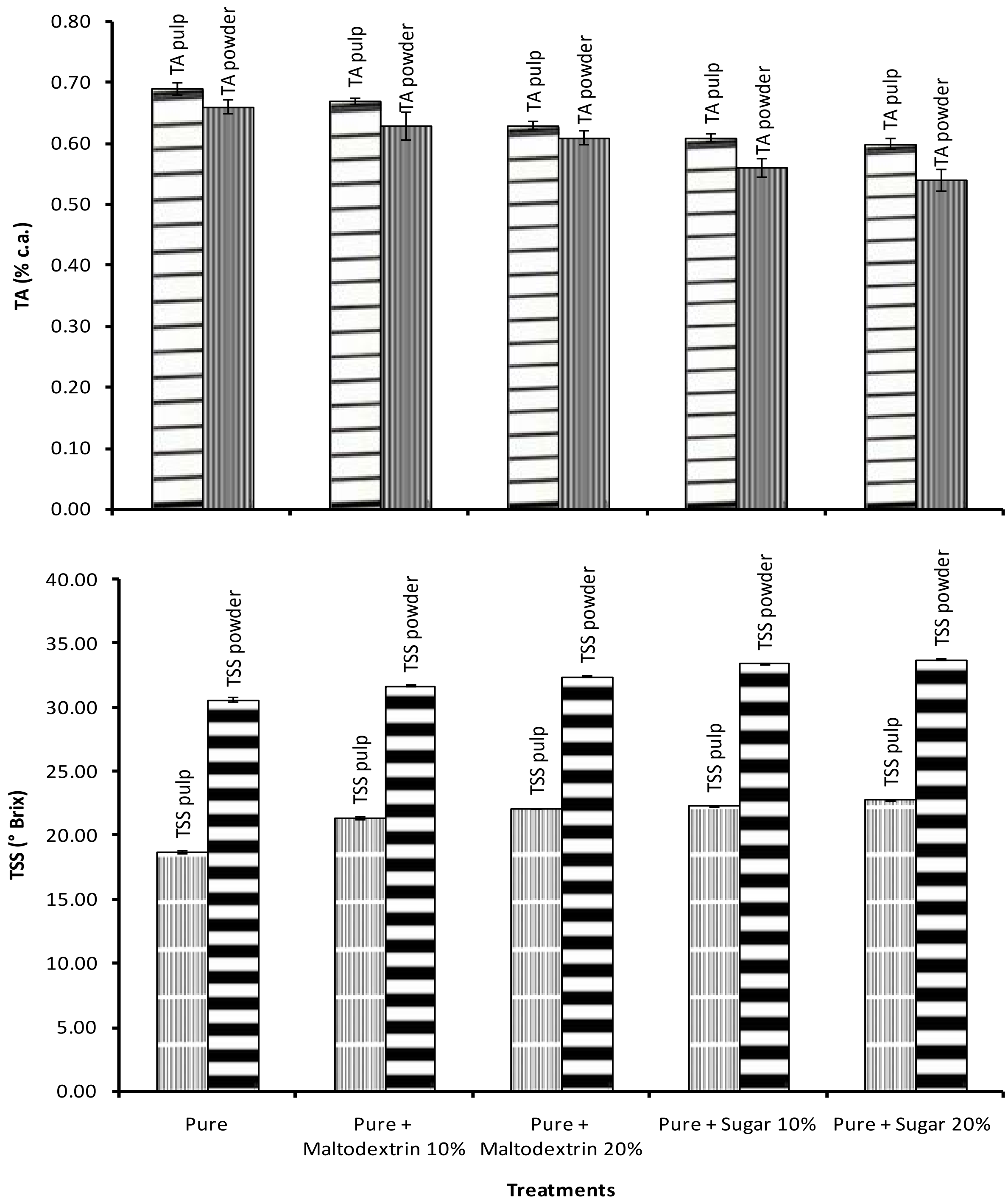

Fig. 1: Changes in Titratable Acidity, TA (% c.a.) and Total Soluble Solid, TSS (°Brix) of Josapine Pineapple Pulp and Freeze-dried Powder at Different Treatments.

Proximate composition (moisture, protein, ash, fiber, fat content)

The results of the proximate analysis of Josapine pineapple pulp and freeze-dried powder are presented in Table 2. The moisture content for treatment with addition of maltodextrin for pulp and freeze-dried powder showed a significant different ($p<0.05$). The close results were reported by Abadio et al. [22] for pineapple, Mahendran [23] for guava, and Brennan et al. [24] for orange. Higher the concentration of maltodextrin during freeze drying process results in the decreasing of moisture content of the freeze-dried powder, due to high solids content and less amount of water (Table 2). It has been reported that the moisture content of freeze-dried powders of less than 3% tends to have good flowing properties. The high moisture content (>80%) in pineapple pulp indicates a low energy value for the Josapine pineapple [20]. Therefore, it showed the usefulness in the treatment of obesity. On the other hand moisture in fruits gives them a natural laxative properties which also a good nutrition to human body [25]. There is no significant difference ($p<0.05$) observed between Josapine pineapple pulp with freeze-dried powder concerning the percent content of protein, fat, fiber and ash. As shown in Table 2, there is only 3.5 to 4% increase in protein, 1.9 to 2.2 % increase in fiber and 1 to 1.3% increases in ash content. These increasing percentages suggest that freeze drying process is the best drying processing in preserving and improving all the delicate and the beneficial nutrients of Josapine pineapple. Fasoyiro et al. [26] reported a high percentage of fat content in roselle powder. The fat content of Josapine pineapple is found close to those reported by Romero-Rodriguez et al. [27] and Mbogo et al. [20] . Samson [28] reported that low levels of fat content imply that fruits are not good sources of energy and hence need to supplement with other sources of fat for proper body nutrition. Even though there is an increasing pattern for fiber and ash content throughout the drying of the pulp, the values are still not significantly higher which implies the low amount of inorganic compounds in the Josapine pineapple fruits.

Table 2: Proximate Analysis of Josapine Pineapple Pulp and Freeze-dried Powder at Different Treatments

Treatments	Proximate analysis (%)				
	Moisture content	Protein	Fat	Fiber	Ash
Pulp					
Pure	91.17±0.31	4.41±0.04	0.34±0.10	5.03±0.10	0.80±0.03
Pure + Maltodextrin 10%	88.66±0.06	4.39±0.08	0.34±0.03	4.99±0.03	0.78±0.02
Pure + Maltodextrin 20%	87.90±0.12	4.14±0.14	0.33±0.02	4.97±0.02	0.78±0.01
Pure + Sugar 10%	90.56±0.02	4.26±0.19	0.34±0.02	4.95±0.02	0.79±0.03
Pure + Sugar 20%	90.68±0.03	4.19±0.24	0.34±0.11	5.02±0.11	0.81±0.02
Powder					
Pure	2.44±0.01	7.98±0.03	0.56±0.03	7.25±0.17	2.07±0.06
Pure + Maltodextrin 10%	2.07±0.05	7.97±0.05	0.54±0.07	6.95±0.07	2.03±0.05
Pure + Maltodextrin 20%	1.98±0.03	8.00±0.04	0.55±0.04	6.97±0.04	2.05±0.08
Pure + Sugar 10%	2.87±0.02	7.98±0.04	0.58±0.02	6.99±0.12	2.02±0.05
Pure + Sugar 20%	2.92±0.02	7.95±0.01	0.54±0.04	7.01±0.09	2.00±0.06

Data represents mean ± SD of triplicate analysis

Water activity, A_w and pH

Water activity is a very important parameter to indicate the availability of water in food systems and to determine the shelf life of powder produced throughout the freeze drying process [29]. There are significant decrease ($p<0.05$) in the A_w value throughout the drying process of Josapine pineapple pulp into freeze-dried powder. This may be due to water loss through evaporation during the drying process. Water activity (A_w) measures the activity of free water in food system which responsible for any biochemical reactions. As shown in Figure 2, all the treated powder possessed lower A_w than that of pulp (Figure 2). It indicates that there is less free water in powder available for biochemical reactions, which is advantageous for longer shelf-life. Food with A_w less than 0.6 is microbiologically stable indicating no growth of spoilage organisms and pathogens [30]. The A_w values for all the treatments are below 3. It indicates that all the treatments are microbiologically stable. There are no significant difference ($p<0.05$) between treatments for both pulp and freeze-dried powder for pH values. The pH is consistent for all the treatments. This is due to the balance of pH during drying process. The change of pH due to treatments might be balanced by losing few acids during the drying process [20].

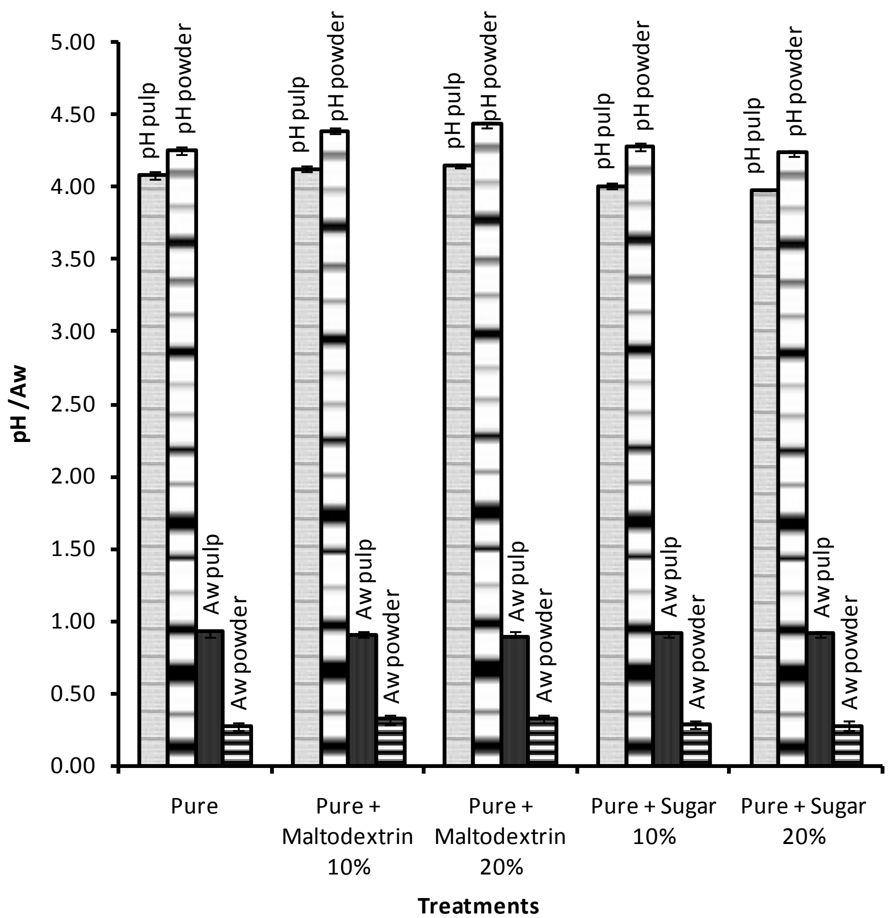

Fig 2: pH and A_w of Josapine Pineapple Pulp and Freeze-dried Powder at Different Treatments

Sensory Evaluation

There was no significantly difference ($p<0.05$) between the acceptability of the pulp juice and the freeze-dried powder drink. Most of the panelists prefer the freeze-dried drink with addition of sugar for the colour, aroma, flavour and sweetness. Freeze-dried with addition of maltodextrin is not favaourable due to the thick consistency and off-flavour. But it is essential to add to minimize hygroscopicity of the powder. The result is in contrast with the one that reported by Askar et al. [19]. According to them there is a significant lost in quality of guava powder and cannot be accept by most of the consumers. This may be due to the difference in the compositions of the fruits and their sensitivity to freeze drying process.

Table 3: Sensory Analysis of Josapine Pineapple Pulp and Freeze-dried Powder at Different Treatments

Treatments	Sensory analysis scores				
	Colour	Aroma	Flavour	Sweetness	Total acceptability
Pulp					
Pure	9.1^{b}	9.3^{b}	8.3^{a}	8.8^{ab}	35.5^{b}
Pure + Maltodextrin 10%	8.4^{a}	9.2^{b}	8.6^{a}	8.6^{a}	34.8^{a}
Pure + Maltodextrin 20%	8.6^{a}	9.3^{b}	8.5^{a}	8.7^{ab}	35.1^{b}
Pure + Sugar 10%	8.9^{ab}	9.2^{b}	7.5^{c}	7.6^{c}	33.2^{a}
Pure + Sugar 20%	8.5^{a}	9.0^{b}	7.2^{c}	7.2^{c}	31.9^{c}
Powder					
Pure	8.8^{ab}	8.5^{a}	7.3^{c}	7.1^{c}	31.7^{c}
Pure + Maltodextrin 10%	8.3^{a}	8.4^{a}	7.6^{c}	7.4^{c}	31.7^{c}
Pure + Maltodextrin 20%	8.1^{a}	8.2^{a}	7.8^{ac}	7.4^{c}	31.5^{c}
Pure + Sugar 10%	8.7^{ab}	8.8^{ab}	8.6^{a}	8.8^{ab}	34.9^{a}
Pure + Sugar 20%	9.0^{b}	8.7^{ab}	8.8^{ab}	8.6^{a}	35.1^{b}

Values are the means for the sensory evaluation completed by 20 panellists.
Values in the same bearing different letters are significantly different.

Caking behavior

Analysis was carried out to investigate how varying the addition of maltodextrin and sugar influences the caking behaviour of freeze-dried pineapple powder. Each of the powder with different treatments were exposed to atmosphere at 23°C for 6 h. Each powder was disturbed using a spatula after 6 h and assessed visually for caking behaviour. The recorded caking behaviour presented in Table 4. Freeze-dried powder with 10 and 20 % of maltodextrin resulted in soft caking after 6 h exposure than that of pure powder and powder containing 20% sugar. It indicates that addition of maltodextrin decreases the hygroscopicity of the freeze-dried powder. The reason behind it structure of the additives. Maltodextrin is a long chain of dextrose and sucrose is a disaccharide. High molecular weight additive is more effective in reducing hygroscopicity of spray dried fruit powder [31].

Table 4: Effect of the Treatments on the Caking of Freeze-dried Powder

Treatments	Caking behaviour (visual assessment)
Pure	Hard cake
Pure + Maltodextrin 10%	Soft cake
Pure + Maltodextrin 20%	Soft cake
Pure + Sugar 10%	Soft cake
Pure + Sugar 20%	Hard cake

CONCLUSIONS

Based on the physicochemical properties data and analysis, one-way analysis of variance (ANOVA) can help in discriminating freeze-dried powder prepared from pulp with addition of maltodextrin and also pulp with addition of sugar.. No significant nutrient loss was observed in freeze-dried powder compared to fresh pulp. The 3.5 to 4% increase in protein, 1.9 to 2.2 % increase in fiber and 1 to 1.3% increases in ash content signifying that freeze drying process is the best drying processing in preserving and improving all the delicate and the beneficial nutrients of Josapine pineapple fruits. Addition of high molecular additives was found beneficial to overcome the caking problem.

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