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Effect of Pretreatments on Quality Attributes of Air-Dehydrated Pineapple Slices

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Abstract: The effect of pre-treatment methods on drying kinetics and quality attributes of air-dehydrated pineapple slices was investigated. *Smooth cayenne* pineapple specie obtained from Nigeria Institute of Horticultural Research (NIHORT), Ibadan was used for the study. A 2 factor-factorial experimental design of 3-levels of 3 pre-treatment methods (sucrose, blanching and sulphiting) and 1-level of drying temperature/drying time resulting into 27 treatments was used for the study. The physico-chemical qualities of the fresh pineapple fruit were determined before hand peeling and slicing to spherical slices of 5 cm radius/0.5 cm thickness. The slices were air-dried in a cabinet direr; the moisture and ascorbic acid content were monitored during drying and the physical and chemical qualities of the dried products analysed at the end of drying. The data obtained were analysed statistically using the Statistical Analysis System. The results revealed that there were significant effect ($p<0.05$) of the pre-treatments on moisture, pH, TTA and ascorbic acid of the samples before drying. Sample pre-treated with $S0_2$ absorbed moisture from 82.41% of fresh pineapple to 83.53% while the 60% sucrose sample had a reduction to 81.70%. The quality attributes showed that there were significant differences ($p<0.05$) between the mean values of the samples. The 60% S/60°C B/2500 ppm $S0_2$ at 70°C drying had the least value of moisture content of 8.75%; 25.16 mg/100 g of ascorbic acid and 1.19% fibre. The result of the web diagram of the sensory evaluation indicated that the 60% S/2500 ppm $S0_2$, 40% S/60°C B/2500 ppm $S0_2$ and 60°C B/2500 ppm $S0_2$ ranked the first, second and third on overall quality acceptability, while the control sample was rated the least in all the evaluated sensory attributes. The statistical analysis revealed that there were significant effects of the pre-treatment methods on the quality attributes of the samples.

Key words: Pineapple slices, pretreatments, attributes, air-dehydrated

INTRODUCTION

Air dehydration of fruits had been reported to be limiting in some factors especially on the quality of the dried fruits (McMinn and Magee, 1997). According to research reports, the quality deterioration can be categorized as nutritional, physical and chemical in nature, McMinn and Magee (1997). The removal of moisture during drying is attributed to these changes on the dried products (Karim, 2005; Alvarez *et al.*, 1995).

Browning and disruption of tissues of dried fruits owning to presence of polyphenols are the physical characteristics and one of the major set backs in fruit drying (Karim, 2005; Chrife, 1983). Other physical changes affecting dried fruit quality are shrinkage of cells, loss of rehydration ability, wettability and case hardening (Dalgleish, 1988; McMinn and Magee, 1997). Also irreversible cellular rupture and dislocation, resulting in loss of integrity and hence a dense structure of collapsed or greatly shrunken capillaries, with reduced hydrophilic properties on tissues of dried fruits as reported by Jayaraman *et al.* (1990). Large differences are found on the reported data on the nutritive value of dried fruits and are reported to be due to wide variations in the preparation procedures, drying temperature and time and the storage conditions (Bhardwaj and Kaushal, 1990; Levi *et al.*, 1980; Mazza, 1982, 1983).

Losses during preparation are also reported to be high, which may sometimes exceed those caused by drying operation. Also vitamins have different solubility in water and as drying proceeds, some (for example riboflavin) become super saturated and precipitate from solution. Other chemical changes like pH, TTA, soluble sugar, are also reported to occur during drying. These are found to be associated with the transfer of mass and energy during dying (Lozano *et al.*, 1980; Uddin and Halwder, 1990). On the other hand the acceptability of dried fruits is usually based on the retention of nutritive value and light brown product that can be stored for a long period. Different pretreatment methods have been developed for fruit dehydration, among which are sulphiting, osmotic pretreatment, blanching etc (Karim, 2005; Alvarez *et al.*, 1995; Levi *et al.*, 1980).

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Sulphur dioxide, which possesses bactericidal properties and inhibits enzymatic and non-enzymatic darkening has been found to be applicable to air dehydration of fruits (Levi *et al*., 1980) for control of browning of cut fruits during drying. Embs and Markakis (1965) earlier found that the mechanisms of SO_2 inhibition of browning caused by Polyphenol Oxidase (PPO), is the SO_2 reaction with some substrate compounds (such as the enzymatically produced o-quinones from the existing polyphenols), as well as direct enzyme inactivation by the SO_2. However, Levi *et al*. (1980) noted that SO_2 has effect on pectolytic enzyme activity and on textural properties of SO_2 pre-treated and dehydrated banana.

While blanching of the vegetable tissue as a pre-drying treatment is usually carried out to prevent off flavours and colour changes resulting from enzymatic reactions. It is also applied to decrease the initial microorganism load. Blanching is considered in the literature to affect the rate of vegetable drying in many ways. Saravacoes and Charm (1962) found that steam blanching of potato has no significant effect on drying rate when compared to the control sample dried at 66°C. Vacarezza and Chirife found that blanching both steam and water blanching increased the drying rate of sugar beet due to the loss of soluble solid and the destruction of the semi permeability of the cell membranes. Though, Rostein and Cornish reported that at least for apples, the drying phenomenon was not controlled by the cellular permeability.

Furthermore, Alzamora and Chirife found that blanching, either steam or water decreased the rate of drying potato and they ascribed this effect to changes caused by gelatinization of the starch. In avocado, however, these authors found that steam blanching increased significantly the drying rate of carrot cubes. On the other hand (Alvarez *et al*., 1995) found out that blanching is not always advisable for most commercially prepared tropical fruit products because of its negative effects on their delicate textural properties and other quality characteristics. But Levi *et al*. (1980) reported that blanching had significant effect on drying rates of banana slices.

Many researchers have investigated the effect of osmotic dehydration prior to conventional drying on the rate of moisture transport and product quality. Vaccarezza found that the moisture diffusivity of water in sugar beet root decreased as the sucrose content increased. However, combination of these pretreatments method has not been investigated on some tropical fruits like pineapple. The study thus conducted to evaluate the effect of single and combination of sucrose osmosis, sulphiting and blanching treatments on the quality attributes of air-dehydrated pineapple slices at 70°C drying.

MATERIALS AND METHODS

Freshly harvested pineapple fruits (*Ananas comosus* L.) from NIHORT, Ibadan and Ajanla farm via, Ibadan, Nigeria were used for the study. The fruit had a good indication of physiological maturity and eating quality of flat 'eyes', with a slight hollowness at the centre; enlarged fruit, less firm and more aromatic. The fruits were kept at 18°C and 80-90% relative humidity until used. The fruits were processed within the 48 h of arrival at the laboratory.

Experimental design: A two-factor factorial experimental design was used for the study. The factors were 3-levels of three pre-treatment methods of sucrose osmosis, blanching and Sulphiting (SO_2) treatment and 1-level of drying conditions (temperature/time) viz 70°C/10 h. This resulted into (3×3×3) 27 samples for the study. The experimental ranges of factors (Table 1) were established from preliminary experiment and from published research (Forni *et al*., 1991; Catherine *et al*., 1992).

Analysis: The fresh pineapple fruits were analysed for TTA; pH soluble solids using AOAC (1992) methods. The total soluble sugars was determined using (Dubios *et al*., 1956) method, ascorbic acid content by titration method of Ruck, colour using pineapple water puree with a Hunterlab D25 spectrophotometer at 420 nm absorbance and the absorption values were reported as the intensity of yellow colour of the fresh pineapple fruit. The texture evaluation was carried out according to the Kramer Shear test in an Instron 1140 textroometer. The results were reported as resistance to shear in N/g fresh weight. Pectin was determined using (AOAC, 1992) method and represented as calcium pectate (C_{17} H_{22} 0_{16} C_a). Fruits selected with similar characteristics of ripening were prepared as shown on into spherical shape of 5mm thickness and 20 cm radius.

Pre-treatment of pineapple slices: A batch each of 5 kg of pineapple slices were pre-treated with sucrose solution, blanching and chemical treatment with SO_2 solution according to Table 1. Each sample was weighed before pre treatment and after. The samples were also analysed for

Table 1: Factors and levels of experimental design for the study of effect of pre-treatment on quality attributes of air-dehydrated pineapple slices

	Levels		
Factors	1	2	3
Sucrose/Osmosis	0%	40%	60%
Blanching	0°C	60°C	Steam
Sulphiting	0 ppm	1500 ppm	2500 ppm
Drying conditions	70°C/10 h		-

pH, titrable acidity, moisture and ascorbic acid using AOAC (1992) methods after treatment. However, the samples that were treated with SO_2 were analysed for SO_2 absorption level.

Sucrose-osmosis pre treatment: Pineapple slices were osmotically treated by immersing into aqueous solution of 40 or 60% w/w of sucrose (Food grade of 98% purity) for 10 min. The samples were drained on wire mesh and re weighed.

Blanching pre treatment: Pineapple slices were blanched in warm water at 60°C held in a water bath to maintain the temperature and steam generated from boiling water for 5 and 3 min, respectively at atmospheric pressure. The samples were cooled at room temperature and reweighed before drying.

Sulphurdioxide pre treatment: Pineapple slices were dipped in 1500 and 2500 ppm sulphurdioxide solution made from potassium-meta bisulphate solution for 6 min and reweighed. The samples were analysed for SO_2 retention before drying.

Drying of pineapple slices: The pre-treated pineapple slices were dried in cabinet dryer (Gallenkamp hotbox) under standard conditions on perforated stainless steel trays, of tray loading 1 kg with cross-through airflow. The cabinet dryer consists of an insulated chamber. Hot air was circulated through the cabinet at 1.2 m s^{-1} per square metre tray area. The cabinet has an automatically controlled air temperature and humidity and at constant air velocity. The 27 samples of pineapple slices from the experimental design were dried simultaneously, in order to ensure uniform drying conditions. After drying, the dried slices were analysed for pH; TTA; ascorbic acid; soluble solids; colour intensity and texture as described for the fresh fruit. The rehydration index was determined using (Farkas *et al*., 1982) method.

The sensory evaluation was carried out on the 18 best samples from the physical and chemical analysis results and the samples that maintained the physical and chemical qualities within 0-40% depreciation were selected from each drying condition respectively for the evaluation.

The judges scored for colour, aroma, taste, crispiness and shape using a 9-point hedonic scale where 1 and 9 represent dislike extremely and like extremely, respectively. The samples were coded with three digit random numbers using Keith model. Responses of the panelists were subjected to stastical analysis of variance and means were separated by Duncan's Multiple Range test (Duncan, 1955).

The Overall Quality Index (OQI) was calculated from the equation:

$$OQI = (m_1 \times DL_1) + (m_2 \times DL_2) + (m_3 \times DL_3) + \ldots + (m_x \times DL_n) \quad (26)$$

Where,

DL = Degree of liking for each quality attribute of a product.
m = Quality attribute factor.
n = Number of quality attributes.

From the results obtained for each drying conditions, the best six samples in all the sensory qualities analysed were selected for further analysis. This resulted into twelve samples and the same procedure was used for second stage sensory evaluation. Responses of the panelist were subjected to Statistical Analysis of Variance and means were separated from Duncan Multiple Range Test.

Statistical analysis: All statistical analyses were performed using the Statistical Analysis System (SAS Institute, Inc., 2004). Mean separation was obtained by Duncan Multiple Range test and Analysis of Variance ANOVA was conducted on the mean values to determine the significance of any differences between samples (Duncan, 1955).

RESULTS

Physical and chemical properties of fresh pineapple fruits: The physical and chemical properties of the fresh pineapple fruits are presented in Table 2. The ascorbic acid content of the fruit was 31.46±1.12 mg/100 g fresh weights, while the moisture content was 81.31±1.14% fresh weights. Total dietary fiber of the fruit was 1.42±0.15% fresh weight, while the soluble protein was 15.42 mg/100 g fresh weight. The organic acids of the pineapple fruit represented as malic acid were 0.32% of fresh weight.

Table 2: Physical and chemical qualities of fresh pineapple fruits

Qualities	Values
Texture (N/gf.w)	31.63±0.04
pH	3.52±0.04
Titrable acidity (g citric/100 g.f.w)	1.15±0.01
Soluble solids (Brix)	11.89±0.08
Total dietary fibre (% f.w)	1.42±0.03
Moisture (% f.w)	81.31±1.14
Ascorbic acid (mg/100 g f.w)	31.46±1.12
Soluble protein (mg/100 gf.w)	15.42±0.07
Pectin pigment (ppm Carotene)	0.22±0.01
Organic acids (%f.w as malic acid)	0.32±0.02

Each value represent mean of three replicates. f.w-fresh weight ± -Standard deviation of the mean value

Table 3: Physico-chemical Properties of Pre-treated Pineapple Slices Before drying

Treatment						Properties	
Sucrose (%)	Blanching (°C)	Sulp. (ppm)	Weight (g)	pH	TTA (%)	Moisture* %WB	Ascorbic acid* % mg g^{-1}
0	-	1500	152.11	3.7	1.17	83.82	32.21
0	-	2500	153.06	3.7	1.17	83.53	32.30
0	60	0	151.47	3.6	1.17	84.48	32.00
0	60	1500	151.34	3.7	1.16	83.30	32.24
0	60	2500	151.28	3.7	1.16	83.27	32.26
0	Steam	0	149.36	3.5	1.19	81.98	32.10
0	Steam	1500	151.14	3.7	1.15	83.17	32.21
0	Steam	2500	151.32	3.7	1.15	83.29	32.32
40	-	0	149.06	3.5	1.19	81.78	31.42
40	-	1500	149.32	3.5	1.19	81.96	31.96
40	-	2500	149.21	3.5	1.19	81.88	32.10
40	60	0	148.28	3.5	1.19	81.26	31.12
40	60	1500	148.42	3.5	1.18	81.35	31.86
40	60	2500	148.53	3.5	1.18	81.43	32.06
40	Steam	0	148.02	3.5	1.18	81.09	31.24
40	Steam	1500	148.36	3.5	1.19	81.32	31.62
40	Steam	2500	148.24	3.5	1.19	81.33	31.89
60	-	0	147.30	3.4	1.19	81.70	32.36
60	-	1500	147.82	3.4	1.19	80.95	31.68
60	-	2500	148.0	3.5	1.19	81.09	31.84
60	60	0	146.12	3.4	1.21	79.82	32.49
60	60	1500	147.84	3.5	1.19	80.97	32.43
60	60	2500	147.81	3.5	1.19	80.92	32.21
60	Steam	0	148.42	3.5	1.19	81.36	32.42
60	Steam	1500	148.84	3.5	1.20	81.64	31.43
60	Steam	2500	148.86	3.5	1.20	81.65	31.64

Each value represents mean of 3 replicates, Initial values: Weight of slice-150 g, pH-3.5; TTA-1.17, Moisture content-82.41%, Ascorbic acid-32.51 mg g^{-1}
* _ Significant difference at 5% level

The results obtained from the physical and chemical analysis of the pineapple slices pre-treated with sucrose osmosis, blanching and sulphiting SO_2 before drying are presented in Table 3. Absorption of moisture was observed by the samples pre-treated with sulphurdioxide before drying while those pre-treated with sucrose osmosis had a reduction in moisture content from 82.41% of fresh pineapple slices to 79.82% of sample pre-treated with 60% sucrose osmosis. The sample pre-treated with 60°C blanching had the highest reduction of moisture. While samples pre-treated with 60% sucrose osmosis/ 1500 ppm SO_2 and 60% sucrose osmosis/60°C blanching/ 2500 ppm SO_2 had moisture content reduction to 80.95 and 80.92%, respectively. Increase in moisture content was recorded for samples sulphited with 1500 and 2500 ppm SO_2 to 83.82 and 83.53%, respectively. Samples pre-treated with steam blanching and sulphited with 1500 and 2500 ppm SO_2 also recorded absorption of moisture to 83.30 and 83.27%, respectively. The results also revealed that there was a significant difference between the moisture content of the samples at 5% significant level.

There was leaching of ascorbic acid in some samples. The samples pre-treated with 40% sucrose osmosis/60°C blanching recorded the highest leaching of ascorbic acid to 31.12 mg g^{-1} though there was no significant difference between the ascorbic acid content of all the samples at 5% level. Also there was no significant difference between the mean values of the TTA and pH values.

The effects of pre-treatment methods on quality attributes of the dried pineapple slices are shown in Table 4 and 5. The results indicated that there were significant differences ($p<0.05$) between the mean values of the quality attributes on all the pre-treated dried pineapple slices at both drying temperatures.

The mean values of moisture content ranged between 8.57-14.67% for control sample and sample pre-treated with 60% sucrose/60°C blanching and 1500 ppm SO_2, respectively. While the ascorbic acid retention values ranged between 6.56 mg/100 g for control sample and 29.95 for sample (pre-treated with 40% sucrose/60°C blanching and 2500 ppm SO_2. The pH and TTA values exhibited a close ranged of values of 5.13-6.61 and 1.14-82 g acid/100 gfw, respectively. The soluble solid values ranged found was 11.16-17.77% while the colour ranged between 0.010-0.053 at 530 nm absorption of SO_2 ranged between 0.012-0.022 ppm for the samples pre-treated with SO_2. While the rehydration index range was 37.00 mL for control sample with the lowest value and 47.67 mL for sample pre-treated with 60% sucrose and 60°C blanching (Table 6).

Table 4: Effect of sucrose, Blanching and Sulphiting pre-treatment methods on moisture, ascorbic acid and fibre content of dried pineapple slices

Pretreatment	pH	TTA g citric acid/100 gfw	Moisture (%)	Ascorbic Acid mg/100 g	Fibre (%)
Control	6.32j	1.04a	14.67k	6.56a	1.46cd
40%S	6.06f	1.30def	10.14bcdef	5.97a	1.35bcd
60%S	6.51lm	1.39efgh	9.80abcde	7.58b	1.19ab
60°CB	6.51lm	1.10abc	12.23h	10.72d	1.45d
Steam B	6.60m	1.10abc	12.30h	9.08c	1.24abc
1500ppm SO_2	6.19ghij	1.06ab	13.46j	23.73I	1.38cd
2500ppm SO_2	5.74cd	1.35efg	10.42def	25.58mn	1.27abc
40%S/60°CB	6.35jkl	1.33defg	10.53ef	7.62bc	1.24abc
40%S/Steam B	6.61m	1.27def	12.33h	10.89d	1.32abcd
60%S/60°CB	6.34klm	1.46ghi	9.76abcde	5.81a	1.28abc
60%S/Steam B	6.03efg	1.62jk	8.99ab	9.05c	1.32abcd
60°CB/1500 ppm SO_2	6.06fgh	1.11abc	12.67ijk	19.36jk	1.34bcd
60°CB/2500 ppm SO_2	5.52b	1.45ghi	10.64ef	24.01lm	1.20ab
Steam B/1500 ppm SO_2	6.23ghij	1.19bcd	12.51i	15.56efg	1.25abc
Steam B/2500 ppm SO_2	5.50b	1.52hij	10.38cdef	25.35lm	1.16a
40%S/1500 ppm SO_2	6.06fgh	1.37fgh	10.44def	16.83g	1.27abc
40%S/2500 ppm SO_2	5.47b	1.40fgh	10.96efg	25.58m	1.27abc
60%S/1500 ppm SO_2	6.06fgh	1.25def	10.96efg	19.36jk	1.27abc
60%S/2500 ppm SO_2	5.79d	1.45ghi	10.53ef	27.35o	1.19ab
40%S/60°CB/1500 ppm SO_2	5.86de	1.29def	11.21fgh	16.45fgh	1.27abc
40%S/60°CB/2500 ppm SO_2	5.21a	1.68k	9.17abc	29.95no	1.26abc
60%S/60°CB/1500 ppmSO_2	6.13ghi	1.62jk	9.25abcd	14.71e	1.23abc
60%S/60°CB/2500 ppmSO_2	5.59b	1.82i	8.75a	25.16lm	1.19ab
40%S/SteamB/1500 ppmSO_2	6.09fgh	1.26ghi	11.86ghi	15.17ef	1.17a
40%S/SteamB/2500 ppmSO_2	5.52b	1.46ghi	10.12bcdef	25.07lm	1.20ab
60%S/SteamB/1500 ppmSO_2	6.25hijk	1.82i	8.57a	20.56k	1.27abc
60%S/SteamB/2500 ppmSO_2	5.13a	1.81l	8.97ab	27.78o	1.23abc

S-Sucrose; B-Blanching, Means with the same alphabet in a column are not significantly different at 5% level

Table 5: Effect of sucrose, Blanching and Sulphiting pre-treatment methods on physical attributes of dried pineapple slices

Pretreatment	Texture N/g f.w	Colour at 530 nm	Rehydrative index Ml
Control	11.12	0.0423abc	37.00a
40%S	11.24	0.038abc	46.33kl
60%S	14.21	0.4033abc	42.33defgh
60°CB	12.26	0.0410abc	42.00defgh
Steam B	12.33	0.039abc	39.33bc
1500ppm SO_2	11.12	0.02367abc	38.33ab
2500ppm SO_2	13.12	0.0100a	40.00bcd
40%S/60°CB	13.10	0.036000abc	40.33efgh
40%S/Steam B	13.21	0.04167abc	40.00efg
60%S/60°CB	13.78	0.04167abc	37.00bc
60%S/Steam B	14.16	0.05167bc	40.67fghi
60°CB/1500ppm SO_2	14.12	0.0533c	34.33a
60°CB/2500ppm SO_2	13.86	0.0200abc	38.00bcd
Steam B/1500ppm SO_2	14.21	0.0100a	39.67def
Steam B/2500ppm SO_2	13.86	0.01300a	40.27fghi
40%S/1500ppm SO_2	13.48	0.02633abc	44.67k
40%S/2500ppm SO_2	13.42	0.01233a	42.00ghij
60%S/1500ppm SO_2	13.51	0.101933ab	39.67def
60%S/2500ppm SO_2	13.60	0.01033a	42.33hij
40%S/60°CB/1500ppm SO_2	13.38	0.01833ab	36.67bc
40%S/60°CB/2500ppm SO_2	13.24	0.0433abc	42.00ghij
60%S/60°CB/1500ppm SO_2	14.21	0.03267abc	40.00efg
60%S/60°CB/2500ppm SO_2	16.22	0.03267abc	41.33fghij
40%S/steamB/1500pm SO_2	13.26	0.02233abc	39.67def
40%S/SteamB/2500pm SO_2	14.8	0.03633abc	41.00fghij
60%S/steamB/1500pm	15.62	0.02567abc	38.33cde
60%S/steamB/2500pm SO_2	15.64	0.0100a	40.33efgh

S = Sucrose; B = Blanching. Means with the same alphabet in a column are not significantly different at 5% level

The ascorbic acid values range was 5.54- 28.53 mg 100/g for control sample and sample pre-treated with 60% sucrose/steam blanching/2500 ppm SO_2, while the colour value range between 0.083 and 0.047 absorption at 530 nm.

A significant difference ($p<0.05$) was recorded in the effect of the pre-treatment methods on the textural property of the dried pineapple slices. The texture values were found to be between 12.06-16.22N/g.f.w shear-force for the samples. The variation in the shear-force found could be related to the different pre-treatment methods given to the slices before drying.

It is also noticed from the results that the higher moisture content was obtained from the samples pre-

Table 6: Mean sensory scores of pre-treated and air dehydrated pineapple slices at 70°C

Sample	Shape	Colour	Crispiness	Aroma	Taste	OQI
Control	2.15k	2.80h	2.60i	4.20ef	2.40h	2.78
60%Sucrose	4.15j	4.55f	2.90i	3.70f	2.95h	3.68
Steam Blanching	4.80hi	3.80g	2.95i	4.30e	4.15fg	3.93
60°C Blanching	5.05ghi	4.30gf	3.10i	4.55e	3.85g	4.13
1500ppmSO_2	4.85hi	4.25gh	5.50cdef	4.30e	4.10fg	4.74
2500 ppmSO_2	5.30efgh	6.25d	5.90bcd	5.15d	5.90bcd	5.74
60%Sucrose/60°C Blanching	5.30efgh	4.40f	5.45cdef	4.45e	4.60f	5.76
40%Sucrose/1500ppmSO_2	4.80i	4.30gh	4.60h	5.50cd	4.55f	5.76
60°C Blanching/2500 ppmSO_2	6.15abc	6.5cd	5.35cdefg	6.30b	6.20abc	6.07
SteamBlanching/1500 ppmSO_2	5.90bcd	7.70a	6.05abc	6.45ab	6.60a	6.51
60%Sucrose/Steam Blanching	5.65defg	5.50e	5.05fgh	5.35d	4.15fg	5.40
60%Sucrose/2500 ppmSO_2	6.35a	7.30ab	6.5ab	6.05bc	6.25abc	6.54
Steam Blanching/2500 ppmSO_2	6.4a	7.65a	6.70a	7.00a	6.75a	6.86
40%Sucrose/60°C Blanching/2500 ppmSO_2	4.85hi	5.60e	5.00fgh	6.35b	6.30ab	5.55
40%Sucrose/60°C Blanching/2500 ppmSO_2	5.50defg	6.80bc	5.20defgh	6.30b	5.65cde	5.88
60%Sucrose/Steam Blanching/1500 ppmSO_2	5.80cde	5.20e	5.75cde	4.35e	4.25fg	5.16
60%Sucrose/60°C Blanching/2500 ppmSO_2	4.60ij	6.20d	4.70gh	5.25e	5.60cd	5.27
40%Sucrose/60°C Blanching/2500 ppmSO_2	4.85hi	5.60e	5.00fgh	6.35b	6.30ab	5.55

Each value represents mean scores by 20 panelists, Mean values having the same letter within column are not significantly different ($p>0.05$)

reated with blanching method while lower values were obtained for the samples pre-treated with sucrose-osmosis and sulphiting at both drying temperature/time.

Generally, it was observed that the higher the SO_2 pre-treatment, the higher the value of ascorbic acid, soluble sugar, SO_2 retention and the lower the colour values. Lower values were recorded for the samples pre-treated with sucrose-osmosis, with the 60% sucrose having the lowest moisture content and consequently lower rehydration value.

DISCUSSION

Tissue darkening usually occurs with increasing high temperature in hot air drying of foods. The values decreased (prevention of darkening) with increasing blanching and sulphited samples. This might have been due to inactivation of the polyphenolic enzymes responsible for enzymatic browning of fruits. On the other hand, steam blanching was responsible for the cooking effects, which caused significant changes in the pineapple slices permeability. This in turn, was responsible for the liberation of soluble constituents into the media, causing dark colour (non-enzymatic browning) and a decreased ability for retention and reaction with the SO_2. The heat of the blanching and SO_2 treatments of the slices prior to drying have a marked effect on the colour of the dried pineapple slices, as well as on its texture. This was found to be significant than the earlier findings of Atkinston and Strachan (1962), Olorunda and Aworh (1981) and Karathanos *et al.* (1995).

The samples with lower moisture content and high fibre content had high rehydration index and firmness. The firmness of the blanched samples was found to be firmer than the unblanched samples at both drying temperatures. This was found to be due to the cooking effect of blanching causing textural alteration in the tissue, which becomes softer or tougher depending on the fruit composition, physical and chemical characteristics (Levi *et al.*, 1980). Also, noticed was the effect of SO_2 content on the firmness of the dried pineapple slices. One of the reasons responsible for the observed effect of SO_2 on firmness could be the SO_2-inactivation of pectolytic enzymes (and the consequent influence on the pectic components) which was not fully inactivated within the 3 min of blanching. Change to the texture of solid foods is an important cause of quality deterioration. According to Fellows (1998), loss of texture is explained to be caused by gelatinization of starch, crystallisation of cellulose and localised variations in the moisture content during dehydration which set up internal stresses. These rupture compress and permanently distort the relatively rigid cells, to give the food a shrunken shrivel appearance. This may be responsible for the variation in the quality of texture of the dried samples and the rehydration index as earlier explained by Maskan (2001).

However, the results showed that the lower the moisture and the fibre content of the dried sample the lower the shear force. Thus, on rehydration the product absorbs water more slowly and did not regain the firm texture associated with the fresh material (Maskan, 2001). It has been established that heat not only vaporize water during drying but also causes loss of volatile components from the food. Invariably the samples pre-treated with the sucrose-osmosis, blanching and sulphiting together exhibited better quality variables due to the combination effects of the blanching and SO_2 as earlier discussed. Thus, the sample pre-treated with 60% sucrose/steam blanching/2500 ppm SO_2 had the recorded lowest moisture content, high ascorbic acid, rehydration index; soluble sugar, colour absorbance and firmness.

The pre-treatment methods also influenced the sensory qualities of the dried pineapple slices as reflected in the judgments of the panelists. The sucrose osmosis pre-treatment enhanced the taste of the drying pineapple slices. This was why sample sucrose osmosis pre-treated was rated the best in terms of taste. However, co-pre-treatment with sulphiting was able to reduce the Maillard browning and the caramelisation that might have occurred from the little absorption of sucrose by the sample. Furthermore, the pre-treatment with SO_2 improved the sensory qualities of the products. This finding is similar to the reports of Levi *et al.* (1980) on effect of pre-treatment of dried fruits on their sensory qualities. Also blanching was found not to be suitable alone for pre-treatment of pineapple slices because of it is negative impart on the sensory qualities (Jayaraman and Das-Gupta, 1992).

The concept of Overall Quality Index (OQI) is used in product development as a measure of the quality index of different products by the computation of the complex quality based on the transformation of the parameters featuring product quality into dimensionless numbers (Herald and Helmet, 1983). The lower the value of OQI, the better the quality of the sample. The little difference in the values of OQI amongst the samples indicates little difference in the overall quality of the samples.

CONCLUSION

Blanching pre-treatment alone was not found suitable for the drying of pineapple slices because of disintengration of cell wall and negative impact observed on the sensory quality. While Sulphiting pre-treatment did not only protect the ascorbic acid from degradation as earlier reported, it also improved effective moisture transport.

The physical and chemical attributes correlate with the sensory characteristics of the products, showing the impact of pre-treatment on the sensory characteristics. Also, the results of the sensory evaluation justify the acceptability of pre-treated/dehydrated pineapple slices. Consequently it could be concluded that combination of pre-treatments of: 60% sucrose/2500 ppm SO_2; 40% sucrose/60°C blanching/2500 ppm SO_2; 60°C blanching/ 2500 ppm SO_2 will be suitable for production of dried pineapple slices.

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