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Effective jam preparations from watermelon waste

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Abstract

Watermelon waste materials remained one of the important food grade agro-wastes generated by most hospitality industries in Southeast Asia and particularly in Malaysia. Jam was prepared from watermelon rind with different flavours (vanilla, pineapple, strawberry, lemon and no flavour). Five different samples were prepared at various compositions T_1 (50-50), T_2 (80-20), T_3 (60-40), T_4 (40-60) and T_5 (20-80) of rind and sugar. T_1 (50-50) gave the best jam set. Ten man panel (trained) evaluated the jam for its sensory characteristics and physicochemical analysis. Sensory evaluation conducted among five flavours was significantly different at ($p>0.05$). Chemical analysis showed that ascorbic acid reduced greatly among all treatments during three month storage. Soluble sugar and pH also decreased gradually for T_1 (from 4.96 to 4.40), T_2 (from 4.92 to 4.21), T_3 (from 4.74 to 4.11), T_4 (from 4.62 to 4.51) and T_5 (from 4.52 to 4.25) upon storage. Strawberry flavoured jam was most acceptable by the panel.

Introduction

Watermelon (*Citrullus lanatus*) is a tropical fruit widely consumed around the world and particularly among Malaysians. The fruit is native to Africa and has been cultivated for thousands of years in many Middle East and South East Asia countries (Koocheki *et al*., 2007). *Citrullus lanatus* thrive more in the tropical regions and enjoy worldwide popularity for its aesthetic tastes and nutritional compositions (Snowdon, 1990). Until recently when farmers experience is used in maturity detection, no distinct methodology has been developed to detect the fruit maturity. One of the methods adopted by farmers is dryness of the crawling tendrils of the plant. Nutritionally, the fruit contains up to 95% water, poor in vitamin C but contain other essential vitamins and minerals necessary for healthy growth (Anon, 2008).

Many cultivars of the plant are currently being grown around the world either at commercial or at peasant level depending on the economy, agricultural practices and technological advancement of the country where it is being grown. Based on these two assertions, both seeded and seedless watermelon were under cultivation among Malaysian farmers. Based on shape, there globular and oblong types while colour may vary in shades of green from pale yellowish green to a deep blackish green. The thin firm external protects the white fleshed internal rind that varies in thickness. Seeded cultivars are dark brown in colour with black oval shaped seeds while the seedless variety may contain only white jellylike seed forms (Yau *et al*., 2010). Currently, about 11,750 hectares of agricultural land are currently under cultivation covering Rompin and Johor producing over 239,050 tones annually for export and local consumption (Anem, 2010).

In recent times, there have been challenges in agro-wastes management due to yearly increase in production in perishable fruits which does not commensurate with consumer utilization (Apsara and Pushpalatha, 2002). Hence more wholesome fruit are discarded indiscriminately in the environment. This development makes reuse and value addition of agro-waste a viable methodology capable of reducing their environmental impact. Several fruits and mixed fruits wastes have been reutilized for producing value added product such as jam with acceptable physical, chemical and rheological properties (Apsara and Pushpalatha, 2002). However, reports of jam made from watermelon rind (WMR) waste is very scarce showing that watermelon wastes from restaurants, food and beverages processing lines are scantly being reused.

WMR is one of the major solid wastes generated by several restaurants, cottage fruit juice producers

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and food industries in Malaysia. Unfortunately, more than 90% of the rind is discarded indiscriminately into the environment thereby constituting environmental challenges. This waste rind is not presently being utilized for any value added processes due to limited research activities focusing on the possible conversion of the waste to other valuable products thereby making it available for dumping as solid waste.

Chemically WMR contain large amount of water with promising levels of solid matters but devoid of high content of soluble sugar. These characteristics made it a viable candidate for the production of high quality jam. This novel use of WMR will among other things reduce the amount of the waste discarded, create more income for farmers, food processors and more importantly reduce environmental impacts of the waste. Therefore, the main focus of this research paper is to successfully document the physicochemical properties and sensory characteristics of jam made from WMR.

Materials and Methods

Fruit waste collection

Fresh watermelon wastes (rind only) with similar physical characteristics were collected from local juice processing restaurants located at Gombak area. The rinds are collected between 9 am and 12 noon in order to maintain their natural content before being stored immediately after collection at $4^{O}C$ to avoid any chemical deterioration before processing day.

Jam preparation

Already prepared watermelon rind was processed into jams according to the Food and Agriculture Organization's guidelines with slight modifications (FAO, 1997). 250 g of the rind was mixed with 250 g of sugar and left at room temperature for 45min (no water was added as the rind contained enough water). The mixture with was heated to boiling and 3ml of citric acid was added to improve taste. For sensory evaluation, five different flavours were added. Five g pectin was added as the rind doesn't form good jell. The produced jams were hot filled into sterilized glass bottles, closed and stored at room temperature ($25\text{-}32^{O}C$).

Ascorbic acid content

Ascorbic acid was determined by iodine titrimetric method using iodine solution. Five g of the sample was weighed and 20 ml of water was added. After filtration, 150 ml of water was added. Starch solution was used as indicator. Supernatant was titrated against 0.005 mol L^{-1} iodine solution until a dark blue black end point was reached. Ascorbic acid was calculated using stoichiometric method. Analysis was carried out at two weeks interval for 90 days.

Formulation of different jam samples

Different jam samples were prepared by varying the percentage (%) composition of WMR and sugar in that order. T_1 (50-50%), T_2 (80-20%), T_3 (60-40%), T_4 (40-60%) and T_5 (20-80%).

Sensory evaluation

Fruit sample for organoleptic evaluation were prepared aseptically in clean transparent disposable closed containers and served fresh on the test day. Ten trained member panel (seven men and three women) were selected from the university community among postgraduate students, evaluated sensory characteristics (appearance, taste, mouth feel, sweetness, flavor and general appearance) of the samples using a 5-point hedonic scale ranging from dislike extremely (1) to like extremely (5) (John *et al.*, 2007). During product testing, panel members were allowed to clean their mouth at intervals.

Statistical analysis

Chemical and sensory characteristics of the jam products were determined in duplicates. The ten previously screened member panel did consumer testing of each differently flavoured samples ounce and data were analysed using SPSS (1995) version 11.5 (SPSS inc., Chicago, IL, USA). One way ANOVA and completely randomized test were conducted to determine significance existing in the mean values at $P \leq 0.05$.

Total soluble sugar content

Total soluble sugar content of the sample was determined by Dubois method of phenol sulphuric acid (1959). Five g of sample was weigh and dissolved in water (by stirring). Phenol sulphuric acid reagents were added to the supernatant. Samples were cooled to room temperature and absorbance was read at 490 nm.analysis was carried out at two weeks interval for 90 days.

Determination of pH

The pH of the jam samples was determined using pre-standardized pH meter and it was carried out every fortnight for 90 days.

Result and Discussion

Screening of jam preparations

Jam is an agglomeration of fruit pulp and sugar at definite proportions. Its characteristic chemical, taste, colour and texture properties are paramount and expected to be stable over the shelf for so time after first opening. Laboratory scale jam procedures were undertaken in order to ascertain jelling properties of WMR as a pre-screening process. Therefore WMR jam samples were prepared with and without pectin. Upon processing, jam samples prepared with pectin gave better gel. This was obvious from the stickiness of the samples with pectin as compared to sample without pectin which showed dropping properties after processing. According to Vidhya and Anandhi (2010), wholesome jam is characterised by thickness, consistency and adequate firmness to hold fruit pulp in position. Hence, jam sample with pectin was selected as candidate for further analysis. The poor gelling property of WMR (peeled) as anticipated may due to removal of outer covering which may contain more of the pectic substances in the rind. The composition of selected sample was varied in terms of rind and sugar while the pectin content was fixed to prepare different jam samples. Result showed that the sample with 50% WRM and 50% sugar gave desirable properties by maintaining the light green colour of WMR tinted with slightly brown sugar colouration. Sample with 20% WMR and 80% sugar was very hard producing undesirable brown colourations upon gelling and this may be due to sugar caramelization (Afoakwa *et al*., 2006). Sugar content of jam remained one of important parameters dictating its aesthetics and stability (Cancela *et al*., 2005)

Effects of storage on ascorbic acid content of jam samples

The physicochemical characteristics of the different WRM jam formulations were studied to ascertain their shelf life properties over three months. Ascorbic acid content of the jam samples were determined at 15 days interval for 90 days in order to check effects of storage on the ascorbic acid degradation and stability. Results showed gradual decrease in ascorbic acid concentration in all treatments (Table 1). Ascorbic acid content decreased progressively between WK2 and WK6 (from 1.14 to 0.92 mol/dm^3) and this might be due to oxidation taking place within the sample as well as enzymatic catalytic reaction taking place within the jam mass during storage. Gradual reductions in ascorbic acid content of jam products over a storage period have been reported. Jawaheer *et al*. (2003) observed same effects on jam made from guava fruits. Another principal cause of ascorbic acid decrease might be residual oxygen present within the container head space (assuming glass ware was impervious to oxygen) assisted by degrading activities of light (Jawaheer *et al*., 2003; Imtiaz and Iftikhar, 2010). Upon oxidation, ascorbic acid normally will be converted to de-hydroascorbic acid (DHA) which also forms di-ketogulonic acid (DKA) due to ring cleavage. The Anaerobic degradation that resumes after head space oxygen is consumed normally may lead to formation of furfural (Singh *et al*., 2009). Similarly, the slight increase in ascorbic acid after 8th week could be due of storage effects (Iftikhar *et al*., 2007). In treatments T_2, T_4 and T_5 the ascorbic acid decreased steadily while abrupt changes were noticed between T_1 and T_3.

Table 1. Ascorbic acid content of the Jam Treatments

Treatment	Ascorbic acid mol/dm^3						
	Fresh	2WKS	4 WKS	6 WKS	8 WKS	10 WKS	12 WKS
T_1	1.37	1.14	1.05	0.92	1.07	1.17	1.13
T_2	1.07	1.61	1.35	1.10	1.20	1.09	1.07
T_3	1.07	1.23	1.23	1.13	1.12	1.31	1.28
T_4	1.38	1.01	1.01	0.96	1.12	1.07	1.06
T_5	1.14	1.51	1.04	1.04	1.27	1.13	1.28

Table 2. pH of Different Jam Treatments

Treatment	Fresh	2WKS	4 WKS	6 WKS	8 WKS	10 WKS	12 WKS
T_1	4.96	4.63	4.47	4.51	4.52	4.40	4.53
T_2	4.92	4.30	4.21	4.32	4.39	4.27	4.26
T_3	4.74	4.46	4.11	4.45	4.49	4.36	4.26
T_4	4.62	4.45	4.62	4.63	4.68	4.58	4.51
T_5	4.52	4.25	4.39	4.52	4.74	4.68	4.61

Effects of storage on pH of jam samples

The pH is one important parameter necessary for optimum gel formation in jams. In this study, the pH of the formulated jam decreased gradually over the 90 days storage period (Table 2). The pH range over the storage period among T_1, T_2 and T_3 showed a movement towards acidity than alkalinity while T_4 and T_5 appeared more stable when compared to initial pH value of the fresh WMR. The general decrease in pH (more acidic) might be due to ascorbic acid degradation, hydrolysis of pectin (Sogi and Singh, 2001) and other acidic compounds such as furfural development from sugar components (Imtiaz and Iftikhar, 2010). The mean values of the pH showed a gradual decrease in pH among the treatments (T_1-T_5) this may due partly to their varying composition. Ehsan *et al*. (2002) observed same trend in mixed fruit jam prepared from watermelon (fleshy part) and lemon. Similarly, reduction in pH of jam prepared from grape fruit apple marmalade was reported by Iftikhar *et al*. (2007). The stable pH in treatments T_4 and T_5 may be due to stable characteristics of sugar and the rind chemical stability. The positive role of sugar content in maintaining the chemical composition of jam products over a period of time

Table 3. Total soluble sugar content of the Jam Treatments

Treatment	Fresh	2WKS	Total soluble sugar mg/g 4 WKS	6 WKS	8 WKS	10 WKS	12 WKS
T_1	80.98	74.80	77.35	67.99	44.67	28.22	20.39
T_2	36.34	30.54	27.34	25.26	22.03	15.59	13.26
T_3	62.10	58.30	43.54	45.10	47.32	32.07	30.07
T_4	86.68	81.40	48.17	50.40	56.66	40.10	36.56
T_5	101.10	96.55	91.14	88.70	71.076	57.79	37.03

Table 4. Sensory evaluation of Jam with different Flavours

Treatments				Flavour	
	Strawberry	Pineapple	No flavor	Vanilla	Lemon
Taste	$4.2±1.1^{b}$	$4.3±1.1^{b}$	$3.5±1.1^{ab}$	$3.1±1.1^{a}$	$4.3±1.1^{b}$
Flavour	$4.8±1.5^{c}$	$4.1±1.5^{bc}$	$2.4±1.5^{a}$	$3.9±1.5^{bc}$	$3.4±1.5^{ab}$
Texture	$4.2±0.9^{b}$	$4.3±0.9^{b}$	$3.5±0.9^{ab}$	$3.1±0.9^{a}$	$4.3±0.9^{b}$
Sweetness	$4.6±1.2^{b}$	$4.0±1.2^{ab}$	$3.1±1.2^{a}$	$4.0±1.2^{ab}$	$3.8±1.2^{ab}$
Mouthfeel	$4.6±0.9^{b}$	$4.6±0.9^{b}$	$3.4±0.9^{a}$	$3.9±0.9^{ab}$	$3.5±0.9^{a}$
Overall	$4.6±1.1^{b}$	$4.4±1.1^{b}$	$3.2±1.1^{a}$	$4.0±1.1^{ab}$	$3.6±1.1^{ab}$

Values with different superscript letters in each row are significantly different (P<0.05)

has been reported (Cancela *et al*., 2005). As the sugar content increased, there was increasing hardness in the jam making it less acceptable to tasters. The same observation was reported by Afoakwa *et al*. (2006) when sugar concentrations was varied from 0% to 100% on constant watermelon pulp.

Effects of storage on soluble sugar content of jam samples

The mean values of the initial soluble sugar showed highest value for T_5 (101.10) and lowest for T_2 (36.34) this was expected since the sugar compositions of treatments differ. There was gradual decrease in soluble sugar among all the treatments during the 90 days storage (Table 3). In T_1, total soluble sugar content decreased from 80.98 mg/g to 20.39 mg/g over the 90 days storage period while in T_2, the sugar content decreased from 35.34mg/g to 13.25 mg/g. Equally, in T_3, it decreased from 62.10 mg/g to 30.07mg/g while decrease was recorded for T_4 (86.68 - 36.56 mg/g) and T_5 (101.10 – 37.03) respectively. This compares very well with result reported previously by Afoakwa *et al*. (2006) when they varied sugar composition in jam treatments. The overall decrease in total soluble sugar among all the treatments over the storage period may be due to chemical hydrolysis caused by low pH of the jam. Reductions in non reducing sugar content of jam upon storage for a known period have also been reported in strawberry jam by Riaz *et al*. (1999).

Sensory evaluation of jam samples

The sensory evaluation results of the investigation were presented in table 4. Generally consumer response was independent of the initial taste of the raw rind. Result showed that in overall, strawberry flavor gave highest mean value (4.6) therefore it adjudged as most acceptable to tasting panels followed by pineapple (4.4), vanilla (4.4), lemon (3.6) and sample with no flavor has least mean (3.2). Statistical analysis showed a significant difference in acceptability among different treatments at p<0.05. For taste the maximum mean value was pineapple (4.3) which is not significantly different from strawberry (4.2) but highly significant to other flavours (vanilla, lemon and no taste). Flavor acceptability was highest for strawberry (4.8) while jam with no flavor at all gave lowest (2.4) means value flavour acceptability. For sweetness, mouth feel and overall acceptability, strawberry flavour was most acceptable and it was significant with mean value (4.6) to all except for taste and texture where pineapple flavour gave highest mean value (4.3) hence, was more acceptable. Similar results concerning flavour acceptability between non-sweet Uapaca and sweet Strychnos fruits were previously reported by (John *et al*., 2007). The lower score recorded generally for the mean values of the treatments may due partly to colour effects inherent in the jam (Saka *et al*., 2002). The overall mean of the jam texture was low among all the treatments. It was 4.3 for lemon and pineapple, 4.2 for strawberry while 3.5 and 3.1 were recorded for No flavor and vanilla respectively. The low texture could be attributed to low concentration of low-methoxyl pectin in the WMR since low-methoxyl pectin is important to improve jam gel properties (Jacklyn and Neela, 2010).

Conclusion

WMR jam was successfully prepared with important parameters studied. Equal proportion of rind and sugar gave is necessary for acceptable result in gel, soluble sugar stability, ascorbic acid and pH. Sensory evaluation result showed wide acceptance of strawberry flavored jam and was significant. The jam long shelf life and stability at ambient temperature for over three months storage was encouraging. The jam preparation with its important acceptable characteristics is capable of being commercialized for industrial use.

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