Original Research Article

Impact of Packaging Materials and Storage Temperatures on the quality of Sugarcane Molasses (black honey)

Abstract

The objectives of the study were to investigate the effects of different packing materials (glass jars, pottery pitchers, plastic jars, and tin containers) and storage temperatures (20°C and 40°C) on the stability and quality of sugarcane molasses (black honey). The physicochemical characteristics (moisture, pH, TSS and total sugar) were determined in order to evaluate the stability and study the changes in the quality of sugarcane molasses, packaged in different materials and stored at 20 and 40 ±1°C during 12month storage period. Results of moisture, pH, TSS and total sugars showed significant decrease in most different storage periods ($p \leq 0.05$). According to the results, the pH value of both sugarcane molasses stored at two different temperatures were the determining factor for all of the examined qualities, which were reduced during storage and influenced the other properties. Moreover, there have been significant differences between products stored at 40°C and those stored at 20°C (at $P \leq 0.05$). As evidenced by the high proportion of physicochemical characteristics, the storage stability of samples stored at 20°C were more prominent than that of samples stored at 40°C. Glass jar and pottery pitcher packaging materials showed the best stability of measured physicochemical properties.

It could be concluded that both glass jar and pottery pitcher packaging materials have good effects as stability and quality agents the others and could be employed as safe packaging preservatives at temperature of 20°C to improve the shelf-life of sugarcane molasses (black honey).

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Key words: Sugarcane Molasses, packaging materials, Physicochemical Parameters, Storage Stability.

1-INTRODUCTION

Egypt sugarcane molasses (black honey) is produced in various governorates in Upper Egypt, particularly in El Minia, Sohag, Kena, and Aswan, where the climate and soil are suitable for sugarcane cultivation. This crop's primary function is to produce sugar. In addition, it is used to make fresh cane juice as a beverage and molasses. A few studies have been undertaken in Egypt to examine sugarcane molasses (black honey) production, manufacturing processes, and the various factors impacting and defining the major features of high-quality sugarcane molasses (black honey). [1].

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Comment [5U]: Repetition. Use both these terms initially. From next stage onwards, use either sugarcane molasses or black honey.

Quality of sugar cane honey should be addressed in both product and process design for its long-term ramifications, which are linked to product acceptance and process feasibility, two interdependent components. This should be given the same weight as economic, technical, and environmental considerations. [2].

Sugarcane honey is a syrupy liquid made from sugarcane juice that has been concentrated until it has a solid content of 65 to 75 % [3]. Treacle (black honey) is liquid syrup prepared by boiling sugar cane juice and evaporating it. Sugars such as sucrose, glucose, and fructose are abundant, and they may crystallize during storage, especially at low temperatures. The biggest challenge faced by treacle makers in the Egyptian traditional food business was crystallization, which had a detrimental impact on quality and market acceptance. [4] & [5] reported that sugarcane-derived foods are good for your health because they are high in nutrients and include natural antioxidants (flavonoids). Within the primary chemicals identified, there was a lot of variety. This meant that determining the quality of treacle solely based on the chemical composition of the primary components was impossible [6].

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[7] studied sugarcane syrups physicochemical and sensory properties. He reported that there is a broad fluctuation in the physicochemical parameters of sugarcane syrup, which does not necessarily signal a problem with technological quality, and it is suggested that the range of values specified in the legislation be revised.

2. MATERIALS AND METHODS:

2.1. Sugarcane molasses:

Sugarcane molasses (black honey) was purchased from the main sugarcane squeezer in Upper Egypt. This squeezer is located in the main sugarcane molasses producing governorate, Kena (Nag Hammady), and was employed in the current study.

2.2. Packaging materials:

Glass jar, pottery pitcher, plastic jar and tin container were acquired at a local shop. The syrup was packed in four airtight, clean dried containers, (glass jar, pottery pitcher, plastic jar, and tin container) at a rate of 1/2 kg per package for twelve months at 20°C in an electric incubator and in the same way, four other packages were then filled and placed in the incubator at 40°C. During a storage period, the physical and chemical properties of sugarcane molasses were studied at regular intervals of 60 days.

2.3. Physicochemical properties:

Moisture content is determined by drying samples at 70 °C until the weight remains constant. Total soluble solids (TSS) were determined using a digital refractometer with a Brix scale of 0-100. The Lane and Eynone Volumetric method was used to determine total sugars. At 25°C, pH values were determined using a Systolic 324 combination glass electrode pH metre. According to the AOAC [8]

2.4. Statistical analysis:

Comment [U7]: To be modified as "Studied physicochemical and sensory properties of sugarcane syrups"

Comment [U8]: 7 has more than one author, it has to be "They" instead of "He"

Comment [U9]: Avoid usage of several terms repeatedly

Comment [U10]: Understood. No need to say again

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Temperatures, storage periods, and packaging materials all had an impact on the sugarcane molasses quality during storage. Therefore, the nutritional values of sugarcane syrup were statistically analyses. Completely Randomized Design (CRD) was employed for the analysis. Significant change levels are listed as $p \leq 0.05$. [9].

3. Results and Discussion

3.1. The physicochemical characteristics:

3.1.1. Effect of packaging materials and storage temperatures on pH value:

Results presented in table (1) indicated a decrease in pH of sugarcane molasses (black honey) stored in all packaging materials along with increasing of storage period. The data recorded that the pH value of the glass jar was 4.967 at zero time of storage, which gradually decreased to 4.00 and 4.19 after the storage period at 20ºC temperature and in 40ºC, respectively.

These findings are consistent with previous findings that indicated that the mean pH value fell over the course of storage, which could be attributed to increased acidity or other chemical reactions. [10].The data revealed that the changes in the pH values of all packaging materials at 20ºC were less than those at 40ºC temperature. From these data, it was cleared that there were highly significant differences ($p \leq 0.05$) between all packaging materials in their pH values at different storage temperatures, packaging and storage periods.

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Table(1):Effect of packaging materials and storage temperatures on pH value.

Tem.	Type of packing	Storage periods (months)							Mean
		0	2	4	6	8	10	12	
Temperature 40 °C	Glass jar	4.96	4.66	4.34	4.32	4.30	4.28	4.00	**4.40**
	Pottery pitcher	4.96	4.86	4.60	4.31	4.28	4.25	4.05	**4.47**
	Plastic jar	4.96	4.33	4.21	4.01	3.99	3.98	3.98	**4.20**
	Tin container	4.96	4.35	4.26	4.09	3.97	3.95	3.94	**4.21**
Mean		**4.96**	**4.55**	**4.35**	**4.18**	**4.13**	**4.11**	**3.99**	**4.32**
Temperature 20°C	Glass jar	4.96	4.75	4.67	4.56	4.43	4.21	4.19	**4.53**
	Pottery pitcher	4.96	4.91	4.75	4.47	4.36	4.29	4.26	**4.57**
	Plastic jar	4.96	4.77	4.68	4.37	4.23	4.16	4.01	**4.45**
	Tin container	4.96	4.53	4.42	4.38	4.25	4.12	4.11	**4.39**
Mean		**4.96**	**4.74**	**4.63**	**4.44**	**4.31**	**4.19**	**4.14**	**4.49**
Mean effect		**4.96**	**4.64**	**4.49**	**4.31**	**4.22**	**4.15**	**4.06**	
F-test A=**		**L.S.D 0.05**	**B =0.04**	**C=0.06**	**AB= 0.06**	**AC=0.08**	**BC= 0.11**.	**ABC=0.16**	

F-test A= Temperatures **

B= Type of packing 0.04

C= Storage periods 0.06

L.S.D0.05 AB= interaction between Temperatures x Type of packing 0.06

AC= interaction between Temperatures x storage periods 0.08

BC= interaction between Type of packing x storage periods 0.11

ABC= interaction between Temperatures x Type of packing x storage periods 0.16

3.1.2. Effect of packaging materials and storage temperatures on T.S.S value:

Table (2) shows total soluble solids, there is a significant differences (at P ≤ 0.05) decrease for the T.S.S. values during storage periods for both two storage temperatures of the four packaged materials. The T.S.S. value was 72.80% at the end of storage period for samples in glass jar while in pottery pitcher was 72.40% for the samples stored at low temperature. Similarly during storage the dry mass of syrups reduced which could affect the brix value [11].

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Table (2) Effect of packaging materials and storage temperatures on T.S.S value.

Tem.	Type of packing	Storage periods (months)							Mean
		0	2	4	6	8	10	12	
Temperature 40 °C	Glass jar	73.90	73.60	73.50	73.30	72.80	72.20	72.10	**73.06**
	Pottery pitcher	73.90	73.80	73.60	73.30	72.20	71.40	71.20	**72.77**
	Plastic jar	73.90	73.30	73.20	73.00	72.00	71.30	71.00	**72.53**
	Tin container	73.90	73.30	73.20	73.00	72.10	71.50	71.10	**72.59**
Mean		**73.90**	**73.50**	**73.38**	**73.15**	**72.28**	**71.60**	**71.35**	**72.74**
Temperature 20°C	Glass jar	73.90	73.70	73.60	73.50	73.10	73.00	72.80	73.37
	Pottery pitcher	73.90	73.90	73.70	73.40	73.00	72.70	72.40	73.29
	Plastic jar	73.90	73.70	73.60	73.30	73.10	72.40	72.00	73.14
	Tin container	73.90	73.50	73.40	73.30	73.20	72.20	72.00	73.07
Mean		**73.90**	**73.70**	**73.58**	**73.38**	**73.10**	**72.58**	**72.30**	**73.22**
Mean effect		**73.90**	**73.60**	**73.48**	**73.26**	**72.69**	**72.09**	**71.83**	
F-test A = *		**L.S.D 0.05**	**B = 0.05**	**C=0.09**	**AB= 0.07**	**AC=0.11**	**BC= 0.12**	**ABC=0.18**	

F-test A= Temperatures *
B= Type of packing 0.05
C= Storage periods 0.09
L.S.D0.05 AB= interaction between Temperatures x Type of packing 0.07
AC= interaction between Temperatures x storage periods 0.11
BC= interaction between Type of packing x storage periods 0.12
ABC= interaction between Temperatures x Type of packing x storage periods 0.18

3.1.3. Effect of packaging materials and storage temperatures on moisture content:

According to the results in Table (3), the moisture content of all packaging materials decreased from 23.50% at zero time to 20.80, 19.70, 19.50, and 19.00% after storage at 40°C. Meanwhile, the loss in moisture content of glass Jar and other packaging materials stored at 20ºC was slightly lower than that of the same packaging material stored at 40ºC. The rate of loss in moisture content of a pottery pitcher was 16.17% at 40ºC and 6.08% at 20ºC after storage.

From the statistical analysis, there were highly significant differences ($p \leq 0.05$) between all packaging materials in their moisture content due to different storage temperatures, storage periods and interactions. The higher loss of moisture content was observed in packaged samples stored at high temperatures. The more rapid decrease in moisture content may be due to moisture evaporation for storage at high temperature [12].

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difference in quality to be mentioned

Table (3): Effect of packaging materials and storage temperatures on moisture.

Tem.	Type of packing	Storage periods (months)							Mean
		0	**2**	**4**	**6**	**8**	**10**	**12**	
Temperature 40 °C	**Glass Jar**	23.50	22.80	22.70	22.80	21.80	21.30	20.80	**22.24**
	Pottery pitcher	23.50	22.90	22.30	21.80	21.00	20.90	19.70	**21.73**
	Plastic jar	23.50	22.90	22.20	21.60	21.20	20.90	19.50	**21.69**
	Tin container	23.50	22.20	21.80	21.10	20.00	19.50	19.00	**21.01**
Mean		**23.50**	**22.70**	**22.25**	**21.83**	**21.00**	**20.65**	**19.75**	**21.67**
Temperature 20°C	**Glass Jar**	23.50	23.40	23.40	23.30	22.90	22.30	22.20	**23.00**
	Pottery pitcher	23.50	23.40	23.30	23.20	23.00	22.80	22.10	**23.04**
	Plastic jar	23.50	22.90	22.80	22.70	22.00	21.80	21.50	**22.46**
	Tin container	23.50	23.10	22.90	22.90	21.90	21.70	21.00	**22.43**
Mean		**23.50**	**23.20**	**23.10**	**23.03**	**22.45**	**22.15**	**21.70**	**22.73**
Mean effect		**23.50**	**22.95**	**22.68**	**22.43**	**21.73**	**21.40**	**20.73**	
F-test A=*		**L.S.D0.05**	**B =0.07**	**AB= 0.09**	**C = 0.12**	**AC=0.11**	**BC= 0.12**	**ABC=0.17**	

F-test A= Temperatures *

B= Type of packing 0.07

C= Storage periods 0. 12

L.S.D0.05 AB= interaction between Temperatures x Type of packing 0.09

AC= interaction between Temperatures x storage periods 0.11

BC= interaction between Type of packing x storage periods 0.12

ABC= interaction between Temperatures x Type of packing x storage periods 0.17

3.1.4. Effect of packaging materials and storage temperatures on total sugar.

From the results in Table (4), it could be noticed that the total sugar content of samples packaged in different packaging materials were decreased from 78.90% at zero time to 75.10, 74.20, 74.00, and 74.10% after storage 12 months at 40ºC. Meanwhile, the total sugar content loss of glass jars and other packaging at 20°C was slightly lower than that of the same packaging during storage. For example, the loss rate of total sugar content of pottery pitchers was 5.95% at 40ºC and 3.17% at 20ºC after storage period. From the statistical analysis, there were significant differences ($p \leq 0.05$) between all packaging materials in their total sugar content at different storage temperatures, storage periods, and interactions. The higher loss of total sugar content was observed in the packaged samples stored at the highest temperatures. The exploitation of sugars in the non - enzymatic browning reaction that occurs during storage could explain the decrease in total sugar concentration. [12,13]. [14] discovered that the total sugar content of date syrup ranged from 71.20 to 91.09 %.

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Table (4): Effect of packaging materials and storage temperatures on total sugare content.

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Tem.	Type of packing	Storage periods (months)							Mean
		0	**2**	**4**	**6**	**8**	**10**	**12**	
Temperature 40 °C	**Glass Jar**	78.90	77.60	77.50	77.30	76.80	76.20	75.10	**77.06**
	Pottery pitcher	78.90	77.80	77.60	77.30	76.20	75.40	74.20	**76.77**
	Plastic jar	78.90	77.30	77.20	77.00	76.00	75.30	74.00	**76.53**
	Tin container	78.90	77.30	77.20	77.00	76.10	75.50	74.10	**76.59**
Mean		**78.90**	**77.50**	**77.38**	**77.15**	**76.28**	**75.60**	**74.35**	**76.74**
Temperature 20°C	**Glass Jar**	78.90	77.70	77.60	77.50	77.10	77.00	76.80	**77.51**
	Pottery pitcher	78.90	77.90	77.70	77.40	77.00	76.70	76.40	**77.43**
	Plastic jar	78.90	77.70	77.60	77.30	77.10	76.40	76.00	**77.29**
	Tin container	78.90	77.50	77.40	77.30	77.20	76.20	76.00	**77.21**
Mean		**78.90**	**77.70**	**77.58**	**77.38**	**77.10**	**76.58**	**76.30**	**77.36**
Mean effect		**78.90**	**77.60**	**77.48**	**77.26**	**76.69**	**76.09**	**75.33**	
F-test A=**		**L.S.D0.05**	**B =0.08**	**C=0.01**	**AB= 0.09**	**AC=0.71**	**BC= 0.13**	**ABC=0.17**	

F-test	A= Temperatures	**
	B= Type of packing	0.08
	C= Storage periods	0. 01
L.S.D0.05	AB= interaction between Temperatures x Type of packing	0.09
	AC= interaction between Temperatures x storage periods	0.71
	BC= interaction between Type of packing x storage periods	0.13
	ABC= interaction between Temperatures x Type of packing x storage periods	0.17

5. CONCLUSIONS:

These results imply that temperatures and storage time are the most important factors in affecting sugarcane molasses quality (black honey). As a result, it was discovered that both of Glass jar and pottery pitcher packaging materials have good effect as stability and quality agents and could be employed as safe packaging preservatives at the temperature 20°C to improve the shelf-life of sugarcane molasses (Black honey).

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6. REFERENCES:

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