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GALAB AS A SUBSTITUTE OF SUCROSE IN TOFFEE AND BISCUITS MAKING.

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ABSTRACT

Jaggery or Galab as so called in Egypt ,is a natural sweetener made by concentration of sugar cane juice. It has great nutritive and medicinal value. It is usually produced in small mills, located near the sugarcane cultivation areas. Present study has been carried out to utilize galab as substitute of sucrose for sweetening toffee and biscuits making. Effect of juice clarification treatments on physico-chemical and quality of processed galab were investigated. Chemical analyses, macro-micro elements, total phenolic of galab were determined and sensory attributes of the produced products (toffee- biscuits) were evaluated. The results showed that treating juice with potassium meta- bisulfate had improved on quality of galab.

Analysis of galab revealed that it contained 7.36% moisture; 1.52% crude protein, 2.41% ash, 0.69% crude fat and 88.02% total carbohydrates. It is good sources of macro and micro elements such as K, Mg, Fe, Cu and Zn. Total phenolic compounds content of processed galab was 3.97% and caffeic acid had the highest percent of phenolic compound in methanolic extract as identified by HPLC.

It can be used in toffee manufacturing as a sucrose substitute up to 50%. The panelist accepted the different biscuits sweetened by galab. So it is a natural and nutritive source of sweeteners that can be utilized for the production of locally available low-cost food to provide the diverse blend of nutrients needed for growth and serve for school children.

INTRODUCTION

Jaggery, a natural sweetener, is consumed in different parts of Egypt as a sweet food. The traditional name of jaggery in Egypt is “Galab”, while it is known as “gur” in Pakistan and Panela in South America. It is unrefined, whole sugars made by the concentration of sugar cane juice without the use of any chemicals, synthetic additives or preservatives. Jaggery contains an enormous wealth of minerals, protein and vitamins which are essential constituents for the body, Kapur and Kanwar (1990), Sonia-Chandra *et al*. (1997) and Singh *et al*. (2007).

Roa and Lak (1999) reported that jaggery contains 70-85% sucrose, 10-15% reducing sugar, 1-2% minerals like calcium, iron and phosphorous, in addition to vitamins A and B, proteins and fats. In India, “gur” is considered auspicious in many parts of India and is eaten raw before commencement of good work or any important new venture (Mahajan *et al*., 1997 and Saroj-Dahiya and Dahiya, 2002).

The micronutrients present (the natural constituents) in Jaggery have useful effects on the human health, it purifies blood, prevent rehumatic effect and having antitoxic and carcinogenic properties, so it has nutritive and medical value (Bokhari *et al*., 1984a; Sahu and Paul, 1998 and Singh *et al*., 2007). A daily single oral of gur (200 mg/kg) for 6 weeks was found to restore the inhibited activity of delta-amino levulinate dehydrase, mean cell haemoglobin content, increased urinary delta amino laevulinic acid excretion,

blood zinc protophyrin and reduced the uptake of Pb in liver, kidney and blood in rat (Flora and Singh, 1988 and Singh *et al*., 2007). Also Sahu and Paul (1998) found that in rats, jaggery can prevent lung damaged from particulate matter as coal and silica dust. Jaggery is used in industrial fermentation process as a carbon source for the economical production of pullulan by the yeast like Fungus *Aurebasidium pullulans* and xanthan (Rajeshwai *et al*., 1995; Vijayendra *et al*., 2001 and Ratnam *et al*., 2005).Therefore ,this work was aimed to improve the characteristics of galab produced under local conditions, to encourage the utilization of galab (Jaggery) in some food products (toffee and biscuit) as a substitute of high price refined sugar and to improve the nutritional value of the selected products .

MATERIALS AND METHODS

Materials:-

Sugarcane (*Saccharum officinarum* L.) variety Co413 was grown under normal recommended practices in the field of Sabahia Agric. Res. Station at Alex. Governorate. The crop was harvested at 12 months age. Then it detrashed, crushed and juice was extracted which used for Galab. In the same time galab cubes were obtained from the local market in Sohak (Tahada) City, Egypt (Fig1.).

Sodium bicarbonate, potassium meta-bisulfite ($K_2S_2O_5$), hydras (sodium hydrosulfite) obtained from El-Gomhoreya for Chemicals and Medical Supplies, Cairo. Sodium bicarbonate, potassium meta-bisulfite ($K_2S_2O_5$), hydras (sodium hydrosulfite) obtained from El-Gomhoreya for Chemicals and Medical Supplies, Cairo.

Biscuit ingredients: Flour, salt, butter, corn oil, eggs, sugar, baking powder were purchased from Alex. Local market, Egypt.Toffee ingredients: Namely lecithin, gelatin, commercial glucose were obtained through of BiscoMisr in Alex., Egypt.

Fig (1): Galab cubes

Methods:-

1-Manufacture of galab cubes: Extracted juice (2 liters) filtered through a cloth to remove any dirt or particles of cane into a large stainless steel pans as rapidly as possible, first using direct flame to boiling point, then indirect using a hot plate different trails (clarification treatments) were carried out during boiling to determine the best one which resulted the best jaggery quality:-

T_1: Treatment of juice with sodium bicarbonate ($NaHCO_3$) to neutralized juice as described by Jadhav *et al*. (2002).

T_2:- Treatment of juice with 0.03% potassium meta-bisulfite ($K_2O_5S_2$) to improve the color (Hilah *et al*., 1984).

T_3:- Treatment of juice with 0.07% hydros (sodiumhydrosulfite, $N_2S_2O_4$) as described by Jadhav *et al*. (2002).

During evaporation, floating impurities were skimmed off. The pans of juice are usually stirred rapidly to incorporate air for an even crystallization. The boiling end point was determined by using refractometer (T.S.S.>80%). Samples obtained from each treatment was cooled, weighted and used for quality analysis.

II-Biscuts and toffee preparation -

a) **Preparation of Toffee**: It was prepared as stated by El-Iraki *et al*. (1987), using the following ingredients:- 33.4% sucrose, 43.4% glucose, 2.7% hydrogenated corn oils, 6.7% milk powder, 11.3% moisture, 0.5% lecithin, 2% starch, 0.04% gelatin. The sucrose was substituted by galab at ratio 25, 50 and 75%.

B) **Biscuits preparation:** Biscuits either plain, with cocoa or peanut were prepared using the dough recipe and baking method described by Nor Aini *et al*. (1992). Then packed in polyethylene bags and stored at room temperature for 4 months.

Analysis :

Moisture, crude protein (N×6.25), crude fat, ash, sucrose, reducing sugar were analyzed according to the procedures of A.O.A.C. (1995). Total carbohydrate was calculated by difference. Total soluble solids were measured using Hand refractometer (Ataga N.I.E., Japan). Purity percent and non sugar substances percent (N.S.S.%) were calculated according to AOAC (1995) by the following equation:-

$$\%\text{Purity} = (\%\text{sucrose} / \%\ \text{T.S.S}) \times 100$$

$$\%\text{N.S.S.} = \text{T.S.S.}\ (\%) - \text{Sucrose}\ (\%)$$

Colour was measured by using Lovibond Schofield Tintometer (Tintometer Ltd., England). The Lovibond values were converted into CIF units (hue, lightness) using visual density graphs.

Minerals (Ca, Fe, Mg, Cu, K, Mn, Zn, Pb and Cd) were estimated using Perkltn Elmer Atomic Absorption Spectrophotometer (Model 2380, England) as described in A.O.A.C. (1995).

Total phenols were determined according to the method of Gamez-Meza *et al*. (1999). Phenolic compounds were identified by HPLC according to Torres *et al*. (1987). Acetic acid 5% (A) and acetonitrile (B), HPLC grade (Fisons Co. England) was used as mobile phase. A C_{18}-CLC-ODS Hypersil reversed phase column, 4.6×250 mm, particle size 5, Col No. 0923002 N was

used. A variable wave length UV detector was used to detect phenolic compounds constituents at 300 nm. For the gradient elution, the solvent system that were used: 100% A and B over 30 min. then 90% A and 10% B over 10 min, 40% A and 60% B over the next 10 min and finally 0% A and 100% B over the final 10 min to purge column. The flow rate was 10 ml/min and identification of the phenolic compounds was based on the comparison of the retention times of peaks which obtained by Torres *et al*. (1987).

Physical characteristics of biscuits: Diameter and thickness of biscuits were measured to obtain the spread ratio according to A.A.C.C. (1983). Biscuits specific lightness and volume were derived according to Elling and MaxMillner (1951).

Sensory evaluation: Colour, taste, flavour, texture and overall acceptability of biscuits and toffee were evaluated by the method recommended by Ranganna (1994) using a Hedonic Rating test. Samples were served to the panelists and they were asked to rate the acceptability of the product on 1-9 points scale, ranging from the extreme like (9) to dislike extremely (1) as described by Larmond (1977).

RESULTS AND DISCUSSION

Effect of clarifying agent on galab quality:-

The main quality characteristics of jaggery are higher sucrose content, purity and lower content of reducing and organic non-reducing sugars (Patel *et al*., ١٩٩0 Misra, 1992; Mungare *et al*., 2000 and Patil *et al*., 2005).

Data in Table (1) showed that treating juice with potassium meta-bisulfite (T_2) lead to higher improvement of galab than other agents. The sucrose content of T_2 (potassium meta-bisulfite) was 74.78% followed by T_1 (sodium bicarbonate) 73.42% and T_3 (sodium hydro sulphite) 71.64%.

Table (1): Effect of clarifying agent on galab quality.

Parameter	Juice	Treatments*			Commercial galab*
		T_1	T_2	T_3	
Yield (gm)	-	281.50	329.00	304.11	-
Moisture (%)	-	6.98±0.62	7.36±0.21	7.08±0.09	8.99±0.57
Sucrose (%)	17.94±0.42	73.42±0.31	74.78±0.19	70.64±0.39	67.11
Reducing sugar (%)	1.03±0.25	5.65±1.00	5.79±0.98	7.03±1.05	12.05
Purity (%)	89.6	90.64±0.38	92.32±0.24	88.44±0.49	-
N.N.S. (%)	2.08	7.58±0.31	6.22±0.19	9.36±0.39	-
Colour					
Red		8.0	6.9	7.3	5.0
Yellow		4.0	9.0	6.0	8.0
Blue		9.9	6.0	8.9	4.1
Visual density		0.43	0.39	0.37	0.29
Bright		31.28	35.87	42.87	34.28
Dominant Hue wave length nm.		591	582	586	581

T_1: Sodium bicarbonate. T_2: Sodium meta-bisulfite. T_3: Sodium hydrosulfite.
***On dry weight basis.**

The increasing of purity could be due to minimizing sucrose hydrolysis by the added salt. Regarding N.S.S., it can be observed from the results in Table (1) that it behaved a contrary run to the purity. Patil *et al*. (1994b) found that the jaggery prepared from plants of 10 months age contained 67.98% sucrose, 13.9% reducing sugar with poor colour, compared to 83.5% sucrose, 5.69% reducing sugar in that of 12 months age plant. Data in Table (1) also revealed that T_2 (addition of potassium meta-bisulpite) gave higher jaggery yield and better colour compared to T_1 and T_3. The results of Lovibond reading colour for the tested samples (Table 1) showed that the treating juice with $Na_2S_2O_5$ (T_2) had lower red and blue values than T_1 and T_3.

T_2 had higher yellow value (9.0) than the other treatments. The hue values which were obtained by converting Lovibond reading to CIE system, ranged from 581 to 591 for all samples. There were differences between all samples in regard to visual density and brightness. These differences may be due to the addition of clarifying agents. These results are in agreement with that of Wit *et al*. (1991), Jadhav *et al*. (2002) and Patil *et al*. (2005). Jadhav *et al*. (2002) reported that the use of hydros (sodium bisulfite) did not improve non-reducing sugars content or colour but increased in reducing sugars values of jaggery. Thus the addition of lime to adjust of juice pH to 6.5 gave better jaggery quality. The yield and quality of the product is influenced by the process used in manufacture, the skill of galab and the conditions of the growing season (Powar and Dongare ,2001).

Chemical composition of galab samples:

The galab prepared by addition of potassium meta-bisulfite was selected for further work. Data presented in Table (2) shows the chemical composition of commercial and prepared galab samples. Total carbohydrate content ranged between 84.75% and 88.02% for commercial and processed samples, respectively. The variation in carbohydrate content may attributed to the difference in chemical composition of the sugarcane juice. These results were in accordance with those given by Kundu *et al*. (1992), Patil *et al*. (1994a) and Singh (2001).

Table (2): Chemical composition of processed (T_2) and commercial galab samples (on dry matter).

Constituent	Processed galab	Commercial galab
Moisture	7.36±0.15	8.98±0.57
Crude protein	1.52±0.24	1.87±0.12
Ash	2.41±0.77	2.97±0.26
Crude fat	0.69±0.04	1.43±0.07
Total carbohydrate	88.02±1.20	84.75±1.02

Mean ± Standard deviation.

Ash and minerals:- As shown in Table (2) the ash content of the commercial and processed samples was 2.97 and 2.41%, respectively. This variation may be due to the difference in cultivation condition and practices or processing conditions. The obtained results was found in the range of the values recorded by Bokhari *et al*. (1984a) who found that ash content in 55 jaggery samples ranged between 1.4-5%.

Data in Table (3) show macro and micro-elements contents of galab. Potassium was the dominant macro-element followed by Ca and Mg. The micro-elements can arranged according to their level as Fe, Cu, Zn and Mn. With regard to the RDA, galab considered a good source of minerals specially for lactating women (National Academy of Science, 2001).

Table (3): Mineral content (mg/100g) of processed galab and their evaluation as RDA (mg).

Elements	Macro-elements			Micro-elements				
	Ca	Mg	K	Fe	Cu	Zn	Mn	Cd
Processed galab	41.82	33.54	354.43	9.37	3.32	2.69	1.76	-
R.D.A*(mg)	1000	310		9.00	1.300	12.00		
Provided RDA* (%)	4.2	10.82		104.1	255.38	22.42		

***RDA for lactating woman according to National Academy of Science (2001).**

Many studies showed that minerals level in jaggery depend on natural conditions of soil, climate, genetic properties of plants, chemical composition of fertilizers and environmental conditions (Parveen *et al*., 1990 and Powar and Dongare,2001).

The iron content of galab reported by other workers was 5.3 mg/100g, 7.5-8.6 mg/100g and 7.7 mg/100g according to Youssef *et al*. (1981), Bokhari *et al*. (1984b) and Nakasone *et al*. (1989). Values of 3.17-6.6 µg/g was reported for manganese by Nakasone *et al*. (1989) and Paraven *et al*. (1990). Parveen *et al*. (1990) stated that jaggery samples contained 2.55 ppm of Zn.

Phenolic compounds content: phenolic content of processed and commercial samples used in this work were 3.97 and 4.48% as gallic acid equivalents. These variations in total phenolic could be due to the sugarcane juice or might be attributed to the effect of heat on the sugar and phenolic amino acid through the maillard reaction.

The phenolic compounds in galab methanolic extract are presented in Figure (2) and Table (4) as determined by HPLC. Coffeic acid, *p*-coumaric acid and chlorogenic acid were shown to be the major phenolic compound in processed galab amounted 61.53, 12.46 and 10.27% of the total phenolic, respectively.

Table (4): Phenolic compound (%) in methanolic extracts of galab as identified with HPLC.

Sample	Phenolic compound	compound (%) of total phenolic
Processed galab	Chlorogenic acid	10.27
	P- hydroxy benzoic (4-hydroxybenzoic acid)	8.70
	β-resorcylic acid (3,6-dihydroxybenzoic acid)	7.02
	Caffeic acid (3,4 dihydroxy cinnamic acid)	61.53
	P. coumaric (4-hydroxy cinnamic acid)	12.46
Commercial galab	Chlorogenic acid	18.87
	P. hydroxyl benzoic acid	6.03
	Protocatechuic acid (2,3 dihydroxy benzoic acid)	12.57
	Caffeic acid	22.80
	Isovanillic acid (3-hydroxy 4-methoxy benzoic acid)	35.35

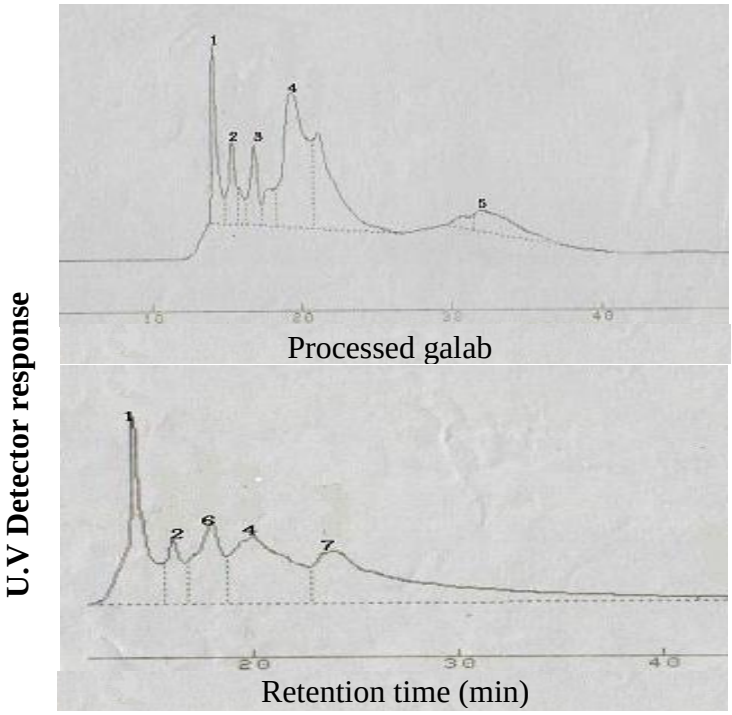

Figure (2): HPLC chromatogram of methanolic extract of galab

Peak number

1-Clorogenic acid;
2- p. hydroxy benzoic (4-hydroxybenzoic acid)
3- β-resorcylic acid (3,6-dihydroxybenzoic acid)
4- Caffeic acid (3,4 dihydroxy cinnamic acid)
5- p. coumaric (4-hydroxy cinnamic acid)
6- Protocatechuic acid (2,3 dihydroxy benzoic acid)
7- Isovanillic acid (3-hydroxy 4-methoxy benzoic acid)

On the other hand, isovanillic, caffeic, chlorogenic acid appeared as the major phenolic compounds in methanolic extract of commercial galab and represent 35.35, 22.80 and 18.87%, respectively.

The present data of phenolic compounds for galab are nearly the same data obtained by Armas *et al*. (1999) and Massoud (2004) who showed that chlorogenic, *p*-hydroxybenzoic, syringic and caffeic acid had the highest percent in methanolic extract of sugarcane and concluded that these compounds had antioxidant activity in vegetable oils.

Quality characteristics and sensory evaluation of toffee and biscuits prepared with galab as replacement of sucrose:

- **Sensory evaluation of toffee**:-

The data in Table (5) revealed that galab can be used in toffee manufacturing as a sucrose substitute for up to 50%. Up to 25% substitution

there is no noticeable difference between the control can be observed. Increasing the ratio of galab to 50% gave an acceptable product but may reduce the texture quality (Fig. 3). The higher ratio of galab than 50% was refused by the panelists and did not keep their shapes.

Table (5): Mean sensory score values of toffee with different ratio of galab substitution.

Ratio of substitution Galab : sugar	Colour	Texture	Taste	Overall acceptability
Control (0 : 100)	8.0	8.5	8.5	8.0
25 : 75	8.0	8.5	8.5	8.0
50 : 50	7.5	8.0	8.0	7.0
75 : 25	6.0	Unacceptable	7.0	Unacceptable

50% Galab 75% Galab

Fig (3): Toffee prepared with galab as replacement for sucrose.

Treacle, is essentially the concentrated cane juice without removal of any sucrose, is used in some food industries to produce malted milk, caramels, toffee and canned fruits and also as a flavouring agent to improve their quality (Hume, 1977; Anon, 1985 and Alvarez, 1987).

- **Physical characteristics of prepared biscuits**

The thickness, volume, specific lightness and specific volume of all biscuits containing 100% galab were increased. Meanwhile biscuits contained 100% sucrose had lower values for the aforementioned properties (Table 6). This may be due to the composition of galab that affected the rheological properties of the produced biscuits.

Table (6): Physical characteristics of biscuits sweetened with galab as replacement of sucrose.

Property	100% sucrose	100% galab		
		Plain biscuit	Cocoa biscuit	Peanut biscuit
Thickness	3.38	3.50	4.00	4.50
Diameter	0.50	0.54	0.46	0.40
Volume of biscuits	75.50	79.00	90.00	98.500
Specific lightness	22.23	23.96	26.60	28.0108
Specific volume	23.79	26.364	29.58	31.287
Spread ratio	6.76	5.93	8.69	11.25

***Specific lightness (volume of 7 biscuits/baked weight of 7 biscuits)×20**
***Specific volume (volume of 7 biscuits / Dough weight of 7 biscuits)×20**
***Spread ratio = width / thickness**

Table (7) and Fig (4) shows the mean sensory score of of biscuits made by using galab as substitute of sucrose. It was clear that;

Table (7):Mean sensory score values of biscuits containing galab as a substitution of sucrose during storage for 4 months at room temperature.

Storage period (month)	Property	100% sucrose	100% galab		
			Plain biscuit	Cocoa biscuit	Peanut biscuit
Zero	Colour	8.25	7.88	8.50	7.70
4		8.00	7.00	8.20	6.50
Zero	Taste	8.50	8.20	8.70	7.00
4		8.00	7.40	8.00	5.50
Zero	Texture	8.00	8.17	8.20	6.77
4		7.50	7.00	7.30	5.50
Zero	Flavour	8.20	8.50	8.70	7.60
4		8.00	7.70	8.50	6.00
Zero	Overall acceptability	8.50	8.40	8.70	7.00
4		8.00	7.50	8.50	5.50

Galab Biscuit

Cocoa biscuit

Peanut biscuit

Fig (4): Biscuits prepared with galab as replacement for sucrose.

- Biscuits sweetened with galab had higher score of flavor and texture than biscuits sweetened with sucrose.

- The mean scores for all sensorial properties of cocoa biscuits with galab were higher than with sucrose as a sweetener.
- All attributes including colour, taste, texture, flavor and acceptability of biscuits prepared with peanut and sweetened with galab were moderately acceptable .
- It was clear that the storage period had affected on taste and texture score but a little difference was found for other sensory properties. These results may be due to hygroscopic attribute of galab.

Galab consumed as a sweet food by many individuals in Egypt. Also, in India, jaggery is used as an ingredient in both sweet and savory dishes (Jain, 1990). Singh et al. (2007) stated that gur is innocent and nutritious food.

In conclusion galab can be used successfully in toffee up to 50% replacement of sucrose, in biscuits up to 100% level. The addition of galab enhanced the nutritional quality specially with iron and other nutritional element that is may play an important role for improving the nutritional status of school children.

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الجلاب كبديل للسكروز فى تصنيع التوفى والبسكويت

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Jaggery أو الجلاب كما يدعى فى جمهورية مصر العربية هو محلى طبيعى من تركيز عصير قصب السكر والذى يتميز بقيمته التغذوية والطبية العالية وعادة ينتج فى المعاصر الصغيرة والقريبة من مناطق زراعة قصب السكر.

أجريت هذه الدراسة للاستفادة من الجلاب كمادة تحلية لمنتجى الطوفى والبسكويت كبديل لسكروز ودراسية تأثير معاملات التنقية لعصير قصب السكر على الصفات الفيزيوكيماوية وعلى نوعية وجودة الجلاب المنتج. كما تم تقدير التركيب الكيماوى وبعض العناصر الصغرى والكبرى والتعرف على المركبات الفينولية للجلاب والتقييم الحسى لتلك المنتجات التى تم تحليتها بالجلاب (التوفى والبسكويت). وأوضحت النتائج أن معاملة العصير بالبوتاسيوم ميتا بيسلفيت يحسن من جودة الجلاب.

وقد أظهر التحليل الكيماوى أن الجلاب يحتوى على ٧,٣٦% رطوبة، ١,٥٢% بروتين، ٢,٤١% رماد، ٠,٦٩% دهن ، ٨٨,٠٢% كربوهيدرات كلية، كما يعتبر مصدر جيد للعناصر الصغرى مثل البوتاسيوم والمجنسيوم والحديد والنحاس والزنك. وأوضحت نتائج التعرف على المركبات الفينولية بإستخدام كروماتوجرافيا السائل عاليه الاظهار HPLC أن حامض الكفيك (caffeic acid) يمثل أعلى نسبة فى المركبات الفينولية والتى تصل نسبتها الى ٣,٩٧% فى الجلاب. كما أوضحت نتائج الخواص الحسية امكانية استبدال السكروز بالجلاب بنسبة تصل الى ٥٠% دون حدوث تغيرات غير مرغوبة فى التوفى.وقد نال البسكويت المحلى بالجلاب بقبول المحكمين حتي نسبة ١٠٠% استبدال للسكروز بالجلاب

لذا يمكن الاستفادة من الجلاب الذى يعتبر محلى طبيعى فى انتاج اغذية مثل البسكويت ذو القيمه التغذويه العالية نظراً لاحتوائها على العناصر الغذائية اللازمة للنمو وخاصة لاطفال المدارس.