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Roselle is a natural source of polyphenols and other phytochemicals such as β-carotene and ascorbic acid that contribute to its antioxidant activity. Roselle calyces can be applied as a material for enriching .different kinds of food systems such as ice cream, processed cheese The processed cheeses were evaluated for total phenol content, antioxidant capacity, chemical, texture and sensory properties during storage at 5-7°C for 3 months. The results revealed that addition of Roselle calyces paste resulted in processed cheeses with higher total solids, fiber, carbohydrates, potassium and total phenolic contents, as compared with the control cheese. However, the control treatment had the highest content of protein, ash, and fat in dry matter, as well as pH values as compared with the other treatments. Moreover, the textural characteristics of processed cheeses containing of Roselle calyces paste were revealed that the hardness, gumminess, cohesiveness and springiness in all treatments were lowest than the control cheese.

Sensory evaluation scores revealed that all processed cheeses containing of Roselle calyces paste treatments were accepted for panels and there were slightly differences between all treatments. Addition of Roselle calyces paste in preparation of processed cheese led to produce a good and acceptable cheese with high nutritional and healthy food and its good for children because Roselle calyces contains red color attractive to children beside contain antioxidants and play important roles ..in the observed health effects

:Introduction

Processed cheese is most of the dairy products that having high consumption pattern by population, specially the children. Processed cheese is becoming increasingly popular form of cheese worldwide; its market is very progressing. It is a complex system composed of, fat, protein, mineral salts and other ingredients. It is produced by blending shredded natural cheeses of different types and degrees of maturity with emulsifying salts (ES), coloring agent and water, and heating the blend under a partial vacuum with constant agitation until a homogeneous .mass is obtained (Awad et al., 2004 and Morsy et al., 2015)

Fruits and vegetables have assumed the status of functional foods, able to provide additional health benefits, like prevention or delaying onset of chronic diseases, as well as meeting basic nutritional requirements. Nowadays, food scientists have collaborated with nutrition researchers to develop plant-based functional foods to promote healthy eating habits .(Mohamed and Shalaby, 2016)

Roselle (Hibiscus sabdariffa L.), is an important medicinal plant native to India and Malaysia, although it grows widely in the tropics and subtropics of both hemispheres and has become naturalized in many areas (Formagio, et al., 2015). In folk medicine, an infusion from the calyces is used as a diuretic and to treat gastrointestinal disorders, fever, liver diseases, hypercholesterolemia, and hypertension (Monroy-Ortiz and Castillo-Espana, 2007). Calyces have therapeutic effects in vivo and in vitro, including anticancer (Olvera- Garcia et al., 2008) and .antioxidant (Ramakrishna et al., 2008) properties

The aim of this study was to produe of processed cheese fortified with Roselle calyces paste. Roselle may insure ingestion of the desired amount of processed cheese with low sodium/potassium ratio and high contents of vitamins and antioxidant compounds especially for children who prefer color product than the normal processed cheese and its analogues. The alterations in the chemical composition, texture and .sensory acceptance caused by Roselle addition also were assessed

:Materials And Methods

:Materials

:Materials and chemicals

Roselle (Hibiscus sabdariffa L.): had been chosen as natural additives. Two kilogram has been obtained locally. Ripened Ras cheese, unsalted soft cheese and butter were obtained from Cairo market. The cheese .was selected by the characteristic flavour of fully ripened Ras cheese

Emulsifying salts (di and tri – sodium phosphate) were obtained from the local market. Milk powder was obtained from MERO Co., Cairo, Egypt.

1,1-diphenyl-2-picrylhydrazyl (DPPH), gallic acid and quercin were purchased from Sigma (St. Louis, MO, USA). Other chemicals and .reagents were of the highest purity available

:Methods

:Preparation of Roselle Calyces Paste

The calyces of Roselle (Hibiscus sabdariffa L.), were separated from seed capsules manually by hand picking. After separation of seed capsule from Roselle, the whole calyces were washed with tap water and remove its seeds mixture by electric blender of good quality to .prepared paste and stored at 4 °C until used

:Ingredients used in the manufacturing of processed cheese

Chemical composition of the ingredients used in the manufacturing of .(١) processed cheese presented in Table

Chemical composition of the ingredients used in manufacture of processed cheese Table (1):

Ingredient	Total Solids (TS %)	% Fat
Cheddar cheese	% ٦٤	% ٣٢,٦
Unsalted soft cheese	٣٢	٠,١
Milk powder	٩٦	٠,٩
Unsalted butter	٨٥	٨٠

:Manufacture of processed cheese spreads containing nature additives

Processed cheese was manufactured, according to the method of Meyer (1973). The composition of control processed cheese treatments was

adjusted to contain 60 ±1% moisture and 51.20 ±1% fat in dry matter. Control processed cheese was made with cheddar cheese, skim milk .powder, unsalted soft cheese and butter as a base blend

Processed cheese treatments manufactured by adding Roselle calyces (Hibiscus sabdariffa L.). Paste in the base blend at ratios of 5 and 10%. All blends were cooked with controlled agitation for 8 min at 85-90°C using direct injection steam at pressure of 1.5 bar. The hot product of processed cheese was manually filled into 150 cc sterilized glass jar and also covered with aluminum foil, then rapidly cooled at 7±1°C. The resultant processed cheese was analyzed as fresh and after 1, 2 and 3 months of storage at 7±1 1°C. The compositions of different blends of processed cheese are shown in Table (2). Three replicates of each .treatment were manufactured and subjected for analysis

Table (2): Formulations of the blends used for manufacture of processed cheese treatments

Ingredient	control	T1 (5% (Roselle paste)	T2 (10% (Roselle paste
Cheddar cheese	٤٠٠	٤٠٠	٤٠٠
Unsalted soft cheese	٢٠٠	٢٠٠	٢٠٠
Milk powder	١٥٠	١٥٠	١٥٠
Unsalted butter	٥٠	٥٠	٥٠
Emulsifying salt	٣٠	٣٠	٣٠
Water	٢٠٠	١٥٠	١٠٠
Roselle calyces paste	-	٥٠	١٠٠
Potassium sorbet	١	١	١

Preparations of Roselle Calyces Extract (RCE)

Dried Roselle calyces were extracted with ethanol (70%) at a ratio of 1:10 w/v (Yu et al., 2005). Ethanol extracts were evaporated in a rotary evaporator (Buchi-water bath-B-480, Switzerland) at 40°C, and freeze-dried (Thermo Electron Corporation- Heto Power Dry LL 300 Freeze .Dryer, Czech Republic). The dried RCE were stored at -20°C

:Determination of total phenolic content (TPC) in Roselle calyces extract

The concentration of TPC in Roselle calyces extract was measured using UV spectrophotometer (Jenway-UV-VIS spectrophotometer), based on a colorimetric oxidation/reduction reaction, as described by Skerget et al., (2005) using Folin-Ciocalteu reagent as oxidizing agent, .the results were expressed as an mg GAE g-1 extract

:Radical Scavenging Activity (RSA %) of Roselle calyces extract

Radical scavenging activity (RSA %) of Roselle calyces extract (RCE) was measured by bleaching of the purple colored solution of DPPH according to Hanato et al., (1988). Percentage of antioxidant activity of DPPH was calculated as follows

DPPH scavenging effect (%) = [(A0- A1)/ A 0]×100 where, A0 is the absorbance of the control reaction and A1 is the absorbance in the .extract. Samples were analyzed in triplicate

High Performance Liquid Chromatography (HPLC) analysis of bioactive :compounds in Roselle calyces extract

For the characterization of active compounds in Roselle calyces extract, HPLC was used to identify and quanti¬tative phenolic compounds. The

composition of solvents and gradient elution conditions were described by Abdalbasit et al(٢٠١٠)

Chemical Analysis

Processed cheese was chemically analyzed for fat, total, soluble and non-protein nitrogen, total solids contents, and titratable acidity as described by Ling (1963). Total carbohydrates were calculated by differences as described by James (1995).Values of pH were measured using a digital pH meter (HANNA), with combined glass electrode (Electric Instruments Limited). Salt content was determined as described by Bradley et al., (1993). Mineral profile of fresh cheese was assayed for determined K, Na contents using a flame photometer (Corning 410, Corning Medical and Scientific Instrument, Modified, MA, USA) as mentioned by Mohamed et al.,(٢٠١١).

:Textural Measurements

Textural measurements of processed cheese treatments were measured using a texturometer model Mecmesin Emperor TMLite 1.17(USA). Mechanical primary characteristics of, springiness, hardness, cohesiveness and gumminess and were assessed from the deformation Emperor TMLite Graph. Also the secondary characteristic of chewiness (hardness× springiness× cohesiveness) was selected because the cheese samples showed springiness (Lobato-Calleros et al., 1997).

:The sensory properties of cheese

The sensory properties of cheese samples were assessed by ten of the staff members of the Dairy Sci., Dep., Fac. Agric., Zagazig, Univ, and Nutr and Food Sci, Dep., Fac. Specific Education, Zagazig Univ.,

according to the scheme of Meyer (1973). The organoleptic scores used consisted of flavor (40 points), body and texture (40 points), appearance .and color (20 points)

:Statistical analysis

The obtained results were evaluated statistically using analysis of variance as reported by McClave & Benson (1991). In addition the other reported values were expressed as mean ±SD and ±SE, two – tailed Student's t test was used to compare between different groups. P value less than 0.05 was considered statistically significant. SPSS (Chicago, .IL, USA) software window Version 16 was used

:Results and Discussion

Chemical composition, minerals content and antioxidant properties of :Roselle calyces

The proximate macro nutrients contents of Roselle calyces are illustrated in Table (3). The results showed that there is a difference between for each macro nutrients contents. Moisture, fat, protein, and crude fiber contents of Roselle calyces were (85.84, 0.94, 2.98, and 2.52 g/100g respectively. These results are in agreement with the results obtained by .(Shruthi et al., (2017

Major element concentrations (mg/100 g on dry weight basis) in Roselle calyces fruits are presented in Table (3). Potassium, sodium, calcium, magnesium, iron, zinc and phosphor contents of Roselle calyces were 350.66, 30.40, 180.31, 197.0, 28.0, 3.20 and 30.68 mg/100g respectively. These results are in agreement with the data obtained by .(٢٠١٣) ,Atta et al

The yield of Roselle calyces extract was 12.22 g extracts/100g. Table (3), the variation in the extraction yields may be attributed to the content of total phenolic compounds of the raw materials and differences in .polarity of these compounds (prakasha et al., 2001)

Roselle calyces, fruits extract were investigated for total phenols (Table 3). The results showed that TPC of Roselle calyces extract was 450.34 mg/ 100g. Roselle calyces extract are good source bioactive compounds namely: poly phenols, carotenoids, vitamins (A and C), microelements and dietary fiber. These compounds have high .antioxidative properties (Formagio et al., 2015)

The radical scavenging activity RSA (%) of ethanolic RCE was 90.60%. These results agree with previous data of Formagio et al., (2015) who studied antioxidant activity of Roselle calyces extract. Therefore, RCE could be a good source of bioactive compounds with high antioxidant .potential

Table (3): Chemical composition, minerals content and antioxidant properties of Roselle calyces

Components	Concentrate
Chemical composition (g/100g)	
Moisture	٨٥,٨٤
Crude protein	٢,٩٨
Crude Fat	٠,٩٤
Ash	٠,٥٦
Crude Fiber	٢,٥٢
Carbohydrate	٧,١٦

Minerals content (mg/100g)

١٨٠,٣١ Ca

٣,٢٠ Zn

٢٨,٠٠ Fe

١٩٧,٠٠ Mg

٣٥٠,٦٦ K

٣٠,٤٠ Na

٣٠,٦٨ P

Antioxidant Activity

(mg/ 100g) ٤٥٠,٣٤ Total phenolic compounds

% ١٢,٢٢ Yield extract

% ٩٠,٦٠ Radical scavenging activity (RSA) %

:Phenolic compounds in plant materials as determined by HPLC

Tables (4) show the percentage of each phenolic compound in Roselle calyces extract. There was a great variation among the components identified by HPLC. Phenolic compounds are widely distributed in nature. It is suggested that the antioxidant activity is related to their cingulated rings and hydroxyl groups (Mattila et al., 2000). Phenolic compounds were identified in Roselle calyces extract namely, protocatechuic, catechol, caffic acid, catechen, epicatechin, vanillic and ferulic with amounts ranging from 22.31- 2008.20 mg/100g. The .(٢٠١٥) ,..obtained results are similar to that reported by Formagio et al

Identification of phenolic compounds in ethanol extracts of Table (4): Roselle calyces as determined by HPLC

Test items	Roselle calyces extract (mg/100 g)
Pyrogallol	٢٠٠٨,٢٠
Protocatechuic	٨٠٠,١٤
Vanillic	٤٨٠,٣١
Chlorogenic acid	١٠٢,٨٣
Catechol	٢٢,٣١
Caffic acid	١٨٠٠,٢٠
Catechin	٩٠٠,١٨
Epicatechin	١٠٠٠,٤٠

Gross chemical composition of processed cheese containing Roselle calyces paste:

Chemical analysis were assessed by determining moisture %, total nitrogen, fat/DM %, salt/ DM, the rate of proteolysis (SN/TN% and NPN/TN %), the rate of lipolysis (TVFA), acidity and pH.

Total solids, fat and fiber content:

Table (5) shows that control cheese had the lowest TS content with 45.40% at the end of storage period (3 months). Cheese containing

Roselle calyces past at different concentrations 5 and 10% showed the TS content with 46.70 and 47.32% respectively at the end of storage period. The TS content of all cheese type significantly ($P \leq 0.05$) increased during storage period for three months at refrigerator temperature. The decrease in moisture content of cheeses along the storage period may be due to the curd concentration and whey expulsion resulting from acid development during the storage period .(Salem et al., 2010)

Concerning fat content, addition of Roselle calyces paste did not effect on fat content for experimental cheese. It could be observed that the Fat/DM content of experimental cheese samples increase significantly ($P \leq 0.05$) up to the end of storage period depending on the loss of moisture. Fat content of all treatments increased along the storage .period up to the end of storage period

Fiber content, processed cheese containing Roselle calyces paste at two concentrations 5 and 10% showed the fiber content with 0.290 and 0.310 % at the end of storage period. The fiber content of all cheese type slightly increased during storage period for three months at refrigerator temperature. These results are in agreement with those reported by Mohamed, et al., (2016) who manufacture processed cheese carrot paste as natural antioxidants. Also, Mehanna et al, (2016) found that addition of tomato juice to processed cheese increased its TS .and fiber contents

:Acidity, pH, ash and total protein

There were significantly increasing trend ($P \leq 0.05$) in acidity of all cheese treatments throughout the storage period. Titratable acidity increased gradually in all cheese samples with the progress in storage period. Roselle calyces paste fortified cheese at a rate of 10% had higher acidity than control cheese. The trend of the changes in pH values of all treatments was opposite to that of acidity (Table 5). Values of pH decreased in all treatments with the progress in storage period. Similar results are obtained by Abd El-Aziz, et al., (2012), Ruben et al., (2013) and Mehanna et al ,(٢٠١٦).

Total nitrogen (TN%) content in cheese samples increased gradually up to the end of storage period and there were no significant differences in TN% along of storage period due to high protein content and lower proteolysis in all treatments. Similar results were reported by Salem, et al., (2010) and Mehanna et al ,(٢٠١٦).

Ash content of cheese containing Roselle calyces paste showed the highest ash content compared to control cheese. The ash content of all cheese type slightly increased during storage period for three months at refrigerator temperature. These results are in agreement with those reported by Mehanna et al., (2016) since who found that addition of tomato juice to processed cheese increased its ash content.

Mineral profile of processed cheese containing Roselle calyces paste:

Results presented in Table (6) showed that the addition of Roselle paste increased K content of processed cheese consequently and the ratio of Na/K was also decreased insignificantly between the treatments. Control sample had 34.60 mg K/100 g, while increased to 313.9 and198.4 mg

K/100 g in cheese fortified with 5 and 10% Roselle paste, respectively. At the end of storage period, it's clear that gradual significant increase was observed with increasing Roselle paste ratios to 10%. The data of Na and K it could be say that this product could be very healthy product for children and any person with the high sodium content causes problem as hypertension. These results are in agreement with these data reported by Mohamed and Shalaby (2016) who found that addition of apricot pulp to processed cheese increased its K content than control .cheese

Table (5): Chemical composition of processed cheese fortified with Roselle calyces paste during storage at refrigerator temperature for 3 months

Samples	Storage period (month)	T.S (%)	Fat (%)	Fat/DM	% Fiber
C	fresh	٣	٢	١	٠
T1	١	٣	٢	١	fresh
	٢	٣	٢	١	
	٣				
T2	fresh	٣	٢	١	٠
	١	٣	٢	١	fresh
	٢				
	٣				

C	T1	T2
١,٥٥±٤١,٧٢		
١,٦٠±٤٢,١٤		
١,٦٠±٤٢,٥٠	١,٥٨±٤٢,٣٠	
١,٦٥±٤٣,٦٠		
١,٧٤±٤٤,٢٠	١,٦٦±٤٤,٢٠	
١,٦٢±٤٥,٢٠		

١,٧٢±٤٥,٤٠	١,٥٨±٤٥,١٤	
١,٦٥±٤٦,٧٠		
٠,٧٥±٢١,٣٦	١,٦٨±٤٧,٣٢	
٠,٦٥±٢١,٣٢		
٠,٧٧±٢١,٨٠	٠,٧٢±٢١,٢٤	
٠,٧٢±٢١,٧٥		
٠,٧٥±٢٢,١٠	٠,٧٥±٢١,٦٤	
٠,٧٥±٢١,٩٦		
٠,٧٦±٢٢,٦٠	٠,٧٤±٢١,٨٣	
٠,٧٨±٢٢,٢٠		
١,٨٥±٥١,١٩	٠,٧٥±٢٢,٠٠	
١,٨٢±٥٠,٥٩		
١,٨٠±٥١,٢٩	١,٧٥±٥٠,٢١	
١,٧٥±٤٩,٨٨		
١,٧٥±٥٠,٠٠	١,٦٦±٤٨,٩٥	
١,٧٢±٤٨,٥٨		
١,٧٧±٤٩,٤٧	١,٦٥±٤٨,٣٦	
١,٦٥±٤٧,٥٣		
– ١,٦٠±٤٦,٤٩		
٠,٠٢±٠,١٩٠		
– ٠,٠٤±٠,٢٠٤		
٠,٠٥±٠,٢١٨		
– ٠,٠٥±٠,٢٦٠		
٠,٠٥±٠,٢٦٨		
– ٠,٠٥±٠,٢٩٤		

٠,٠٦±٠,٢٩٠

٠,٠٨±٠,٣١٠

pH Acidity% Ash (%) Protein (%)

٢ ١ fresh ٣ ٢ ١ fresh ٣ ٢ ١ fresh

٣ ٢ ١ fresh ٣

C

T1

٠,٢٥±١٢,٠٨ T2

٠,٢٢±١١,٩٦

٠,٢٨±١٢,٥٠ ٠,٢٠±١١,٩٢

٠,٢٥±١٢,٢٨

٠,٣٢±١٢,٨٤ ٠,٢٢±١٢,٠٤

٠,٢٥±١٢,٦٢

٠,٣٥±١٣,١٢ ٠,٢٥±١٢,٣٠

٠,٢٨±١٢,٩٤

٠,٢٠±٥,١٤ ٠,٢٣±١٢,٤٨

٠,٢٥±٥,٢٠

٠,٢٢±٥,٣٢ ٠,٢٥±٥,٣٢

٠,٢٢±٥,٤٥

٠,٢٢±٥,٥٨ ٠,٢٥±٥,٥٤

٠,٢٥±٥,٧٣

٠,٢٥±٥,٨٦ ٠,٢٨±٥,٨٣

٠,٢٤±٥,٩٢

٠,١٥±١,٥٨ ٠,٢٦±٦,٠٨

٠,١٦±١,٦٠

٠,١٨±١,٦٢	٠,١٤±١,٦٦	
٠,١٥±١,٦٣		
٠,١٤±١,٦٨	٠,١٨±١,٧٠	
٠,١٦±١,٦٧		
٠,١٥±١,٧٤	٠,٢٠±١,٧٤	
٠,٢٠±١,٧٢		
٠,٣٠±٦,١٢	٠,٢٢±١,٧٨	
٠,٣٢±٦,٠٤		
٠,٢٨±٦,٠	٠,٢٨±٥,٩٢	
٠,٢٦±٥,٩٥		
٠,٣٠±٥,٩٤	٠,٢٥±٥,٨٦	
٠,٢٣±٥,٨٨		
٠,٢٥±٥,٨٤	٠,٢٢±٥,٨٠	
٠,٢٥±٥,٨٢		
٠,٢٢±٥,٧٤		

Mean ± SD in each row having different superscript (a, b, c and d) are significantly different

C- Control processed cheese

.T1- processed cheese containing 5 % Roselle calyces paste

.T2- processed cheese containing 10 % Roselle calyces paste

Table (6): Sodium and potassium content of processed cheese fortified with Roselle calyces paste during storage at refrigerator temperature for 3 months

Storage period (month) Samples

Sodium/ Sodium mg / 100 g Potassium mg / 100 g

Potassium ratio

٢ ١ fresh ٣ ٢ ١ fresh ٣ ٢ ١ fresh

٣

C

T1

٠,٢٦ ±١٢,٤ T2

C

١٠,٤٠±١١٤,٦

B

١٢,٦٠±١٥٠,٥

٠,٦٨±١٦,٨ A

C

١٢,٨±١٦٤,٢

B

١٣,٤±١٨٠,٣

٠,٧٦±٢٢,٢ A

C

١٣,٤±٢٤٠,٨

B

١٤,٢±٢٦٤,٢

٠,٩٨±٣٤,٦ A

C

١٣,٩٢±٢٩٠,٧

B

١٤,٨٠±٣١٣,٩

١٢,٢±١٧٢,٣ A

C

١٣,٥±٢٠١,٧

B

١٣,٦±٢٢٨,٤

١٣,٤±٢١٢,٢ A

C

١٤,٣±٣٢٠,٥

B

١٣,٩±٣٥٠,٤

١٣,٩±٢٧٠,٨ A

C

١٤,٨±٣٩٤,٣

B

١٤,٥±٤٢٠,٦

١٤,٢±٣٢٩,٦ A

C

١٥,١±٤٢٠,١

B

١٤,٨±٤٩٠,٤

١,٤٢±١٣,٨٩ A

A

٠,١٢±١,٧٦

B

٠,١٠±١,٥١

١,١٢±١٢,٦٣ C

A

٠,١٦±١,٩٥

B

٠,١٥±١,٩٤

١,٠٦±١٢,١٩ C

A

٠,١٤±١,٦٣

B

٠,١٣±١,٥٩

٠,٩٦±٩,٥٢ C

A

٠,٠٨±١,٤٤

B

٠,١٢±١,٥٦

C

Mean ± SD in each row having different superscript (a, b, c and d) are significantly different

C- Control processed cheese

.T1- processed cheese containing 5 % Roselle calyces paste

.T2- processed cheese containing 10 % Roselle calyces paste

Total phenolic content (TPC) and radical scavenging activity (RSA %) of : processed cheese containing Roselle calyces paste

Table (7) demonstrated that, there was highly increase in TPC in cheese samples supplemented with Roselle paste and was proportional to the concentration of Roselle paste added. This ascribed to the TPC of Roselle fruit as mentioned before which remained in cheese curd. Control sample had 8.70 mg /100 g, while increased to 290.2 and 310.40 mg /100 g in cheese fortified with 5 and 10% Roselle paste, .respectively at the end of storage period

The obtained results are in according with that data mentioned by Mehanna et al., (2016) who, found that addition of tomato juice to processed cheese increased its TPC content. During storage the TPC gradually decreased for all treated samples (three months), this may be attributed to the transformation of PC which highly unstable compounds and undergo numerous enzymatic and chemical reactions during food .(٢٠٠٦) ,..storage as stated by Poncet-Legrand et al

:Radical Scavenging Activity (RSA %)

Results presented in Table (7) revealed that, supplementing cheese with Roselle paste increased the RSA in the resultant cheese by increasing the percentage of added fruit. It was noticed that, RSA% of control cheese was 1.80 % ,while RSA% of cheese supplemented with 5 and 10% Roselle paste 27.70 and 31.60% respectively, however, the percentage of RSA gradually decreased during storage (three months)

for all cheese treatments. The obtained results are in the same line with those stated by Mehanna et al, (2016) who found that addition of .tomato juice to processed cheese increased its RAS content

Table (7): Radical scavenging activity and total phenolic content of processed cheese fortified with Roselle calyces paste during storage at refrigerator temperature for 3 months

Storage period (month)				Samples			
TPC (mg/100g gallic acid)				RSA %			
٣	٢	١	٠	٣	٢	١	٠
C							
T1							
C٠,٢٢±٢,٨٦				T2			
B١,٤٢±٤٠,٢٠							
C٠,١٤± ٢,٤				A١,٩٨±٤٨,٣٠			
B١,٣٤±٣٦,٦٠							
C٠,٠٨±٢,١٢				A ٧٦ .١±٤٥,٣٠			
B٢٢ .١±٣٢,٤٠							
C٠,٤٠±١,٨٠				A١,٦٢±٤١,٧٠			
B١,١٤±٣٠,٠٠							
C٠,٩٢±٢٠,٠٠				A١,٥٤±٣٨,٩٠			
B١٠,٤٥±٣٩٠,٨							
C٠,٨٥±١٤,٦٠				A١٤,٢٤±٤٢٠,٥			
B١٠,١٢±٣٦٠,٣							
C٠,٦٢±١٠,٥٠				A١٢,٥٢±٣٩٠,٦			

B٩,٨٤±٣١٠,٤

C٠,٤٤±٨,٧٠ A١١,٥٠±٣٦٠,٨

B٨,٦٢±٢٩٠,٢

A١٠,٣٦±٣١٠,٤

Mean ± SD in each row having different superscript (a, b, c and d) are significantly different

C- Control processed cheese

.T1- processed cheese containing 5 % Roselle calyces paste

.T2- processed cheese containing 10 % Roselle calyces paste

Textural properties of processed cheese containing Roselle calyces .paste

The compositional differences between the experimental processed cheeses were in line with the expected differences from the used formulations and the resultant cheeses that were clearly unlike in some .textural attributes, especially firmness

Treatments with high ratios of Roselle paste were in general softer, while those with lower content were firmer and easier to handle (Tables 8). The shortage in firmness caused by the increase in the moisture content of the treatments was expected. It occurs due to the greater hydration and consequent weakening of the casein network (Pereira et .al., 2001)

The addition of Roselle paste resulted in a significant ($p \leq 0.05$) decrease in the supplemented cheese firmness in comparison with the control sample. Furthermore, raising Roselle paste (10%) results in general tendency for a decrease in firmness. This can be related to the fact that

Roselle paste has low protein content. On the other hand, Kaminarides et al., (2006) reported that increasing the Halloumi cheese, salt and ash contents of the blend increased the hardness of the resulting processed cheese.By the same way, the other textural parameters included cohesiveness, gumminess, chewiness, springiness and resilience, were decreased significantly by increasing the ratio of Roselle paste. Korish and Abd-Elhamid (2012) mentioned that the lowest values of hardness, springiness and chewiness in Kareish cheese, may be due to the .increase in cheese moisture content

Organoleptic properties of processed cheese containing Roselle calyces :paste

The average, score points given for appearance body characteristics and flavour of processed cheese as affected by adding Roselle calyces paste are illustrated in Table (9).These results showed that there were significant differences between the control and all treatments when fresh and during storage period. Control cheese recorded the highest score for appearance compared with other cheese. Cheese made with Roselle .calyces paste showed the lowest score for organoleptic properties

All cheese treatments had been acceptable by panelists it is also that all additives improved cheese properties and over all acceptability. Also, organoleptic properties of all cheese treatment improved by progressed of storage period until the end of storage. These results are in agreement with the results obtained by Abd El-Aziz et al., (2012) who found that addition of ginger extract to processed cheese increased its organoleptic properties and Mehanna et al, (2016) who found that

addition of tomato juice to processed cheese increased its organoleptic .properties

Texture profile analysis of processed cheese fortified Roselle calyces paste during storage at refrigerator temperature for 3 months Table (8):

Samples	Storage period (month)	Firmness			Cohesiveness			Gumminess		
		fresh	١	٢	fresh	١	٢	fresh	١	٢
C		٨,١٢±٠,٤٥	٦,١٨±٠,٢٥	٥,٩٢±٠,٢٢	٨,٨٤±٠,٥٠	٦,٦٤±٠,٢٨	٦,٣٢±٠,٢٤	٩,٢٢±٠,٥٤	٦,٩٨±٠,٣٢	٦,٨٤±٠,٢٨
T1		٩,٦٠±٠,٦٢	٧,٦٤±٠,٣٦	٧,١٤±٠,٣٤	١,٠٤±٠,٠٥	٠,٩٨٨±٠,٠٢	٠,٩٦٢±٠,٠١	١,٢٢±٠,٠٨	٠,٩٤٢±٠,٠٢	٠,٩٠٤±٠,٠١
T2		١,٣٦±٠,١٠								

٠,٠١±٠,٩٢٠

٠,١٢±١,٤٠ ٠,٠١±٠,٨٧٠

٠,٠١±٠,٨٩٠

٠,٢٥±٦,١٢٠ ٠,٠١±٠,٨٣٠

٠,٢٠±٤,٩٩٠

٠,٢٥±٦,٦٣٠ ٠,٢٢±٤,٦٨٠

٠,٢٢±٥,٢٩٠

٠,٥٠±٦,٨٢٠ ٠,٢٦±٥,٠٩٠

٠,٢٥±٥,٦٣٠

٠,٦٤±٧,١٧٠ ٠,٢٨±٥,٤٥٠

٠,٢٨±٦,١٤٠

٠,٣٠±٥,٨٥٠

Resilience Springiness Chewiness

٢ ١ fresh ٣ ٢ ١ fresh ٣ ٢ ١ fresh

٣

C

T1

٠,٢٤±٦,٤٠ T2

٠,٢٢±٥,٩٦

٠,٢٨±٦,٨٤ ٠,٢٨±٥,٦٤

٠,٢٦±٦,٢٠

٠,٣٥±٧,٢٠ ٠,٣٠±٥,٩٤

٠,٣٠±٦,٦٨

٠,٣٨±٧,٦٢ ٠,٣٥±٦,٣٢

٠,٣٢±٧,١٢

٠,٠٦±١,١٢ ٠,٤٢±٦,٩٠

٠,٠٤±١,٠٢

٠,٠٩±١,٣٢ ٠,٠٢±٠,٩٨٤

٠,٠٥±٠,٩٧٠

٠,١٢±١,٧٨ ٠,٠٢±٠,٩٤٦

٠,٠٣±٠,٩٣٦

٠,١٤±١,٩٦ ٠,٠٢±٠,٩١٢

٠,٠٢±٠,٨٩٠

٠,٠٤±٠,٨٢٢ ٠,٠١±٠,٨٦٢

٠,٠٢±٠,٧٥٢

٠,٠٤±٠,٧٨٦ ٠,٠١±٠,٧٢٠

٠,٠٢±٠,٧٢٠

٠,٠٢±٠,٧٣٤ ٠,٠١±٠,٦٩٠

٠,٠١±٠,٦٩٨

٠,٠٢±٠,٧١٤ ٠,٠١±٠,٦٤٨

٠,٠١±٠,٦٥٤

٠,٠١±٠,٦٢٨

Mean ± SD in each row having different superscript (a, b, c and d) are significantly different

C- Control processed cheese

.T1- processed cheese containing 5 % Roselle calyces paste

.T2- processed cheese containing 10 % Roselle calyces paste

Table (9): Organoleptic properties of processed cheese fortified with Roselle calyces paste during storage at refrigerator temperature for 3 months

Storage period (months)			Samples
٣	٢	١	fresh
Total	Flavoure (40)	Body textur (40)	Appearance (20)
Total	Flavoure(40)	Body textur4e (40)	Appearance (20) (١٠٠)
Total	Flavoure (40)	Body textur4e (40)	Appearance (20) (١٠٠)
Total	Flavoure (40)	Body textur4e (40)	Appearance (20) (١٠٠)
(١٠٠)			
٠,٦٨±١٨			C
١,١٤±٣٤			A
١,٤٠±٣٨			A
٣,٦٠±٩٠			A
٠,٦٤±١٦			A
١,٠٨±٣٣			A
١,٤٢±٣٦			A
٢,٩٤±٨٥			A
٠,٤٦±١٥			B
١,٠٤±٣٢			A
١,٤٨±٣٦			A
٢,٧٢±٨٣			A
٠,٦٥±١٤			A
١,٠٨±٣١			A
١,٣٥±٣٥			A
٢,٩٠±٨٠			A
A			
٠,٥٦±١٣			T1

١,١٢±٣٢	B
١,١٨±٣٢	B
٢,١٨±٧٧	C
٠,٦٠±١٣	C
١,٠٠±٣٠	B
١,٠٠±٣١	C
٢,٠٨±٧٤	C
٠,٢٨±١٢	C
٠,٩٨±٢٩	B
١,٠٢±٣٠	C
٢,٠٠±٧١	C
٠,٤٨±١١	C
٠,٨٨±٢٨	B
٠,٩٨±٢٩	C
١,٩٨±٦٨	C
	C
٠,٤٨±١٢	T2
١,٢٠±٣٤	C
١,٢٦±٣٤	A
٢,٨٨±٨٠	B
٠,٥٨±١٢	B
١,٠٢±٣٢	C
١,١٤±٣٣	B
٣,١٦±٨٧	B
٠,١٥±١١	B

١,٠٠±٣٠ C

١,١٦±٣٢ B

٢,٧٤±٨٣ B

٠,٣٦±١٠ B

٠,٩٤±٢٩ C

١,٠٤±٣١ B

٢,٩٢±٨٠ B

B

Mean ± SD in each row having different superscript (a, b, c and d) are Significantly different

C- Control processed cheese

.T1- processed cheese containing 5 % Roselle calyces paste

.T2- processed cheese containing 10 % Roselle calyces paste

:Conclusion

From the all results and sensory evaluation results, it could be concluded that the addition approximately 10% Roselle calyces paste in the processed cheese have significant effect on the overall acceptability score of it and in the same time introduced a new healthy alternative processed cheese with favorable properties especially for children. In the same time, the Roselle calyces paste cheese is a novel type of product for health awareness, such as antioxidant properties, low sodium potassium ratio and high content of vitamins and minerals than .the normal processed cheese

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إنتاج جبن معامل وظيفى مدعم بعجينة بتلات الكركديه

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يعتبر الكركديه مصدر طبيعي للفينولات العديدة وغيرها من المواد الحيوية مثل البيتا كاروتين وحمض الأسكوربيك التي لها نشاط مضاد للأكسدة. كما يمكن استخدام بتلات الكركدية كمادة طبيعية فى أنواع مختلفة من النظم الغذائية مثل الآيس كريم والجبن المطبوخ. وفى هذا البحث تم صناعة الجبن المطبوخ بنسب مختلفة (٥و ١٠ ٪). من عجينة بتلات الكركديه. وتم تقييم الجبن المصنعة الناتجة من حيث محتوى المواد الفينولية والنشاط المضاد للاكسدة والخصائص الكيميائية، والتركيبية والحسية خلال التخزين على ٤ درجات مئوية لمدة ٣ أشهر.

أظهرت النتائج أن إضافة عجينة بتلات الكركديه ادت الى انتاج جبن مطبوخة ذات محتويات عالية للمواد الصلبة والألياف والكربوهيدرات والبوتاسيوم و الفينولات الكلية، مقارنةً بجبن المقارنة. ومع ذلك، فان جبن المقارنة كان الأعلى فى محتويات البروتين والرماد والدهون بالنسبة للماد الجافة، وكذلك قيم الرقم الهيدروجيني مقارنة مع المعاملات الاخرى. علاوة على ذلك، تم الكشف عن الخصائص التركيبية للجبن المصنعة المحتوية على عجينة بتلات الكركدية واتضح أن الصلابة والتماسك في جميع المعاملات كانت أقل من جبن المقارنة. من ناحية أخرى، كشفت

درجات التقييم الحسي أن جميع الجبن المصنعة المحتوية على عجينة بتلات الكركدية تم قبولها من قبل المحكمين وكانت هناك اختلافات طفيفة بين جميع المعاملات.

وفى النهاية يمكن القول بأن اضافة عجينة بتلات الكركدية الى الجبن المطبوخ ادت لانتاج جبن جيد ومقبول حسيا ذو قيمة غذائية وصحية عالية ومرغوب لدى الأطفال حيث تعطى اللون الاحمر المرغوب لديهم بالاضافة الى احتواء الجبن الناتج على مضادات الأكسدة والتى لها دور هام للصحة.