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## Research Article

# Impact of Kaki (*Diospyros kaki*) Juice on the Rheological, Sensory and Color Properties of Spreadable Processed Cheese Analogue

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## Abstract

**Background and Objective:** Kaki (*Diospyros kaki*) is a famous and delicious fruit which have a very high nutritive value where it contains ascorbic acid, iron, flavonoid and polyphenols as well as fibers. The main purpose of this article was to study the influence of kaki fruit on the properties of sweet or salted-processed cheese samples to produce a novel type of cheese with high nutritive value. **Materials and Methods:** Sweetened and salted Kaki processed cheese-spreads samples were prepared by using cheese base. Two types of Kaki cheese were prepared beside control sample; the first was prepared by emerging 20% kaki juice and 12% sugar (T1). The second one was prepared by adding 20% kaki juice and 5% table salt (T2) and control sample (C). Prepared processed cheese samples were stored at  $5 \pm 1$  °C for 3 months. All fresh samples were chemically analyzed for their total solids, total protein, fat, salt and soluble nitrogen contents. The values of SN and pH, color parameters, texture profile and the sensory evaluation were conducted during storage period. **Results:** The obtained data showed that soluble nitrogen content was less in sweet sample rather than salted one. Data revealed also that adding Kaki juice decreased the pH values of samples either in fresh or stored ones. The color data indicated that (L) stimuli (which expressed the degree of whiteness and darkness) was increased in the control rather than kaki fortified samples where the later showed yellowish-red color. The organoleptic evaluation revealed that fresh cheese samples in T1 gained the highest scores for appearance, flavor and overall acceptability. However, it had low degrees in color, texture and spreading quality. **Conclusion:** It could be concluded that prepared processed-cheese-spreads samples using kaki fruit was available with acceptable properties.

**Key words:** Processed cheese spread, kaki fruit, color parameters, texture profile

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**Competing Interest:** The authors have declared that no competing interest exists.

**Data Availability:** All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Processed cheese spreads (PCSs) are most popular dairy product consumed by people in different ages. They are characterized by delicious taste, spreadable texture, favorite acceptability, long stability and lower refrigerating cost<sup>1</sup>. Consumption of PCSs by Egyptian is in an increasing rate, where they reached<sup>2</sup> about 32000 t year<sup>-1</sup> in 2016. The processing varied according to the target of their preparation. Some researchers fortified them with different healthy supplement<sup>3</sup> others, prepared them using highly antimicrobial agent<sup>4</sup>. In the same side<sup>1</sup>, prepared PCSs using direct acidification and so on.

In the recent years, the researches; dealt with preparation of sweet processed cheese spreads, SPCSs are increased and grow in high speed rate to serve consumers demands especially children and individual people. In Egypt; Mohamed *et al.*<sup>5</sup> manufactured them with carrot past or apricot pulp<sup>6</sup> and Pomegranate<sup>7</sup>. El-Dardiry *et al.*<sup>8</sup> also produced PCSs containing Quinoa paste, while Kassem *et al.*<sup>9</sup> prepared SPCSs using pumpkin pulp.

Kaki (*Diospyros kaki*) is a delicious fruit which have a very high nutritive value. It is named persimmon in Japan; Shizi in China and kaka in Egypt; generally it is consumed as a fresh fruit and it has a positive potential effect on human health<sup>10</sup>. It is considered a moderate source of energy (70 calories/100 g) and very low in fats. It is also considered a good source of dietary fiber where every 100 g of fresh fruit holds 3.69 or 9.5% of recommended daily intake of fiber. In addition, it contains many bioactive compounds, especially ascorbic acid and iron. Kaki fruit contains also flavonoid and polyphenolic anti-oxidant compounds such as catechins and gallic catechins. The Catechins are known to have anti-infective, anti-inflammatory spreadable and anti-hemorrhagic properties. Kaki contains also other antioxidant compounds like vitamin-A, beta-carotene, lycopene, lutein, zeaxanthin and kryptoxanthin<sup>11</sup>.

So, the present study aimed to prepared an imitate type of spreadable processed cheese fortified with a delicious fruit rich in iron, fiber and antioxidant compounds to boosts the nutritive value of the final product and enhanced its sensory properties. The study was applied in two forms salted or sweetened-processed cheese samples.

## MATERIALS AND METHODS

Kaki fruit and Fresh cow butter were purchased from Egyptian local market. Raw cow milk was obtained from Faculty of Agriculture, Cairo University, Giza, Egypt, while Calf rennet and skim milk powder were obtained from Dairy

Technology Lab, National Research Centre, Egypt. Commercial emulsifying salts (JOHA) were obtained from BK-Ladenburg, Germany.

This study was achieved at February to October (2018). All experiments were done in Dairy Chemistry and Technology Laboratory in Dairy department, National Research Centre, Giza Egypt.

**Experiments:** Kaki fruit was well washed and cut into small pieces, then it was immersed in boiling water for 2 min and well mixed in a kitchen-mixer for 15 min to obtain a smooth and homogenized juice Its TS content was 9.5%. Kaki juice was stored under freezing conditions until used.

**Manufacture of cheese base:** Cow milk was heated (82°C/2 min) and cooled rapidly to 39±1°C. Calcium chloride (about 0.04%) and 4% of calf rennet powder (after diluted 10 times with water) were added and left to coagulate in about 2-3 h. The resultant curd was put to cheese molds over-night, then stored at 5°C till be used as cheese base in preparation of PCSs as mentioned by Kassem *et al.*<sup>9</sup>.

**Manufacture of processed cheese spreads:** Two types of kaki-processed-cheeses were prepared beside control sample. The control processed cheese (C) was prepared to be almost 59±1% moisture and 36±1% fat in dry matter. Treated samples were manufactured by adding kaki juice in the cheese base blend at ratio of 20% (w/w), then sugar was added at 12% in the first treatment (T1) and 5% table-salt was added to the second treatment (T2). All blends were cooked and agitated for 10 min at 85-90°C using direct injection steam at pressure of 1.5 bar. The hot products were manually filled into 100 sterilized-glass-cups, well covered, then rapidly cooled and stored at 5°C for 3 months. All samples were analyzed when fresh and after 1 and 3 months. Three replicates for each treatment were analyzed. The total solids and fat percent of ingredients used in preparing of processed cheese spreads PCSs analogue was presented in Table 1 and the formula of all samples were adjusted as mentioned in Table 2. The composition and pH values of all fresh samples were mentioned in Table 3.

**Chemical analysis of processed cheese samples:** Samples of all processed cheese were evaluated for their total solids (TS), total protein (TP), fat, salt and soluble nitrogen according to AOAC<sup>12</sup>.

**Estimation of pH value of processed cheese samples:** The values of pH of all samples were measured by using a digital pH meter with glass electrode (HANNA).

Table 1: Total solid and fat contents (%) of ingredients that used in preparing of processed cheese spreads

Ingredients	Total solids	Fat
Cheese base	30.5	10.5
Unsalted cow butter	83.0	81.0
Commercial skim milk powder	96.0	0.7
Kaki juice	9.5	0.3

Table 2: Blends-formula (%) that used for preparing of processed cheese spreads

Ingredients	C	T1	T2
Cheese base	35.36	28.75	31.69
Skim milk powder	16.75	14.38	15.84
Unsalted butter	13.65	14.38	15.75
Kaki juice (20%)	-	11.50	12.68
Sugar (12%)	-	8.34	-
Salt (5%)	1.30	-	4.60
Emulsifying salt	1.55 <sup>b</sup>	1.72	1.85
Water	32.46	20.93	20.17
Total	100.00	100.00	100.00

C: Control sample without additives, T1: Sweetened samples fortified with 20% kaki+12% sugar, T2: Salted samples fortified with 20% kaki+5% salt

Table 3: Chemical composition and pH values of fresh different processed cheese spreads samples

Items	C	T1	T2
TS (%)	39.85	44.14	44.22
Fat/DM	50.00	36.20	33.02
Total protein (%)	14.80	11.48	12.31
Salt/moisture	1.82	0.80	2.11
pH value	5.74	5.81	5.70

C: Control sample without additives, T1: Sweetened samples with 20% kaki+12% sugar, T2: Salted sample fortified with 20% kaki+5% salt

**Color parameters estimation of processed cheese spreads**

**samples:** The color of the processed cheese spreads samples was recorded using Hunter colorimeter Model D2s A-2 (Hunter Assoc. Lab., Inc., VA, USA). The instrument was standardized using a white tile (top of the scale) and a black tile (bottom of the scale). A specimen of the processed cheese (flat layer) was placed at the specimen port. The tri-stimulus values of the color namely; L, a and b were measured.

Where:

- L : Darkness from black (+) to white (-)
- a : Color ranging from red (+) to green (-)
- b : Yellow (+) to blue (-)

**Rheological properties estimation of processed cheese**

**samples:** Texture profile analysis was performed on samples using the double compression test (Multi test 1d Memesin, Food Technology Corporation, Slinfold, W. Sussex, UK)<sup>9</sup>. Determinations were carried out by a compression load by a plot of force (N) versus time (s). The following parameters were determined according to the definition given by IDF<sup>13</sup>:

Hardness (N) = Maximum force of the 1st compression

$$\text{Cohesiveness} = \frac{\text{Area under the 2nd compression}}{\text{Area under the 1st compression (A2/A1)}}$$

Adhesiveness (N.s) = Negative area in the curve

$$\text{Springiness (mm)} = \frac{\text{Length 2nd compression}}{\text{Length 1st compression (L2/L1)}}$$

Gumminess (N) = Hardness × Cohesiveness

Chewiness (mm) = Gumminess × Springiness

**Organoleptic properties for evaluation of processed cheese**

**samples:** Samples were evaluated by 25 trained staff members of Dairy Department, NRC, Egypt. All samples were evaluated for appearance, spreading quality; texture, color and flavor and whole acceptability. Each item ranged 1-5 scores.

**Statistical analysis:** Statistical analysis of obtained data was carried out using analysis of variance (ANOVA) and Duncan tests with the Statistical Analysis System<sup>14</sup>. A probability of p<0.05 was used to establish the statistical significance.

**RESULTS AND DISCUSSION**

**Soluble nitrogen contents of processed cheese spread**

**samples:** Results shown in Fig. 1 revealed that soluble nitrogen content (SN %) of processed cheese spreads were less in sweetened samples rather than salted one and both treated samples showed less values than control. This may be due to the lower content of the protein in samples as a result of supplementation of 20% kaki and 5% salt or 12% sugar (Table 2). It could be noticed also that SN (%) increased in all samples by storage and this may be due to proteolysis. The same findings were previously recorded by several authors whom mentioned that addition of Quinoa fruit paste, apricot pulp and dates paste in the blends of PCSs significantly decreased the soluble nitrogen content in the final samples<sup>5-8</sup>.

**pH values of processed cheese spread samples:**

The pH values of different PCSs illustrated in Fig. 2 showed that PCSs fortified with kaki juice largely affected the level of acidity, expressed in pH value. Fresh control sample had 5.74, while fresh salted sample gained 5.50 against 5.31 for sweetened sample. This may be a result of kaki acidity itself where the initial pH values of kaki fresh fruit was previously reported as 5.9 while its acidity was 0.81% so that it is considered an acidic supplement<sup>11</sup>. Also, the storage of samples resulted in elevation of acidity in all samples.

**Color parameters of processed cheese spread samples:** As shown in Table 4, it could be noticed that (L) stimuli (which expressed the degree of whiteness and darkness) increased

Table 4: Color tri-stimulus values of processed cheese spread samples during storage for 3 months at 50°C

Samples	Fresh	1 month	3 months
<b>L</b>			
Control	86.95	86.11	84.66
Salted (T2)	73.80	73.20	72.15
Sweetened (T1)	71.34	71.08	70.89
<b>a</b>			
Control	-2.68	-2.70	-2.83
Salted (T2)	14.22	14.70	15.31
Sweetened (T1)	16.13	16.53	17.26
<b>b</b>			
Control	25.01	25.30	25.88
Salted (T2)	37.04	37.48	37.92
Sweetened (T1)	38.87	38.93	39.02

C: Control, T1: Sweet samples with 20 % kaki+12% sugar, T2: Salt samples with 20% kaki+5% salt, L: Darkness from black (0) to white (100), a: Color ranging from red (+) to green (-) and b: Yellow (+) to blue (-)

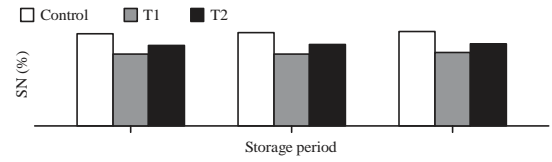


Fig. 1: Soluble nitrogen (%) of processed cheese spread samples fortified with kaki fruit

C: Control, T1: Sweetened samples with 20% kaki+12% sugar, T2: Salted samples with 20% kaki+5% salt

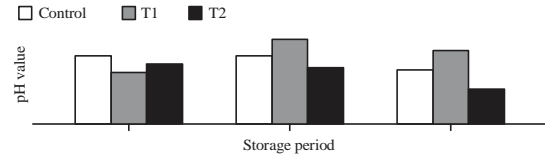


Fig. 2: pH values of processed cheese samples fortified with kaki fruit

C: Control, T1: Sweetened samples with 20% kaki+12% sugar, T2: Salted samples with 20% kaki+5% salt

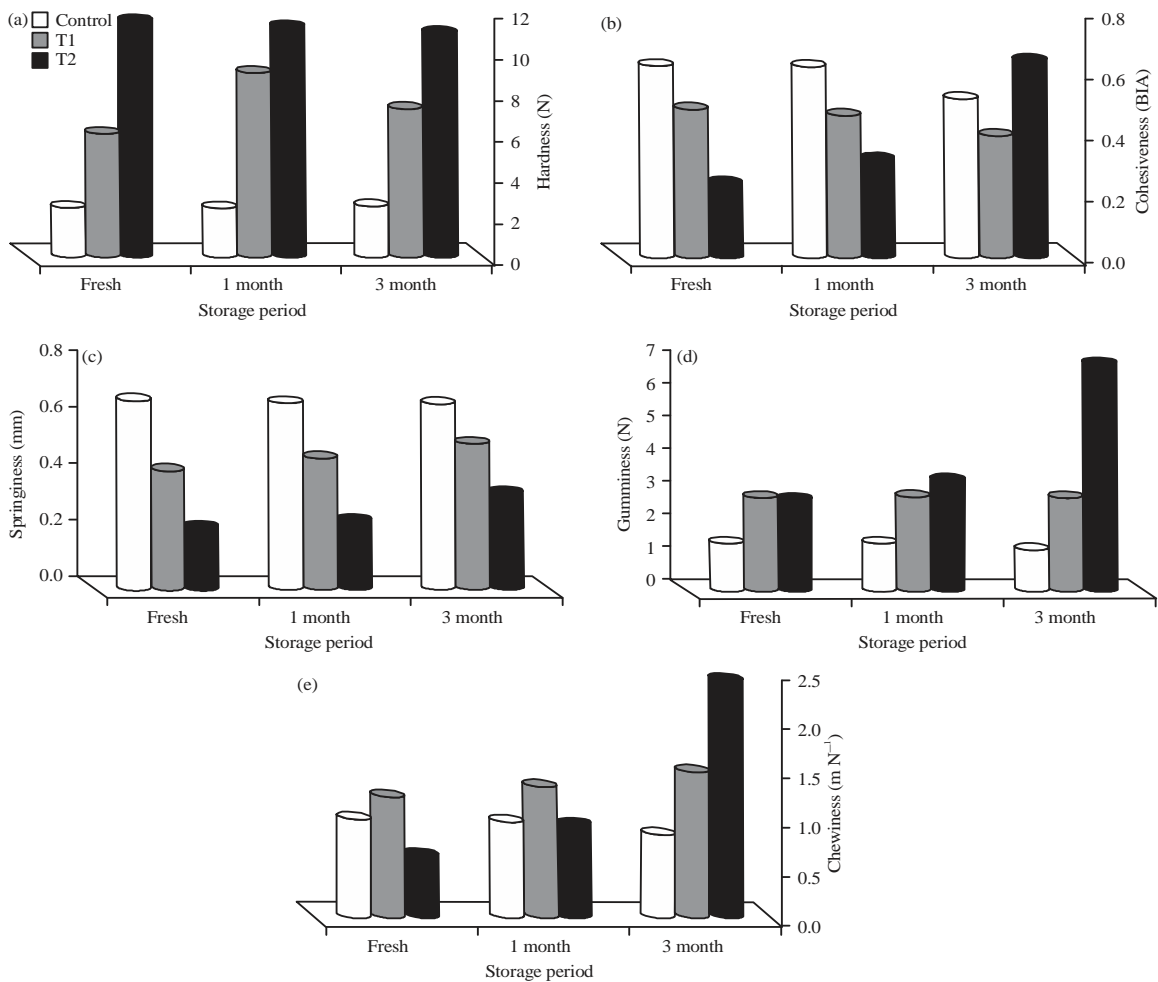


Fig. 3(a-e): Texture properties of processed cheese spread samples fortified with kaki fruit

C: Control, T1: Sweet samples with 20% kaki+12% sugar, T2: Salt samples with 20% kaki+5% salt

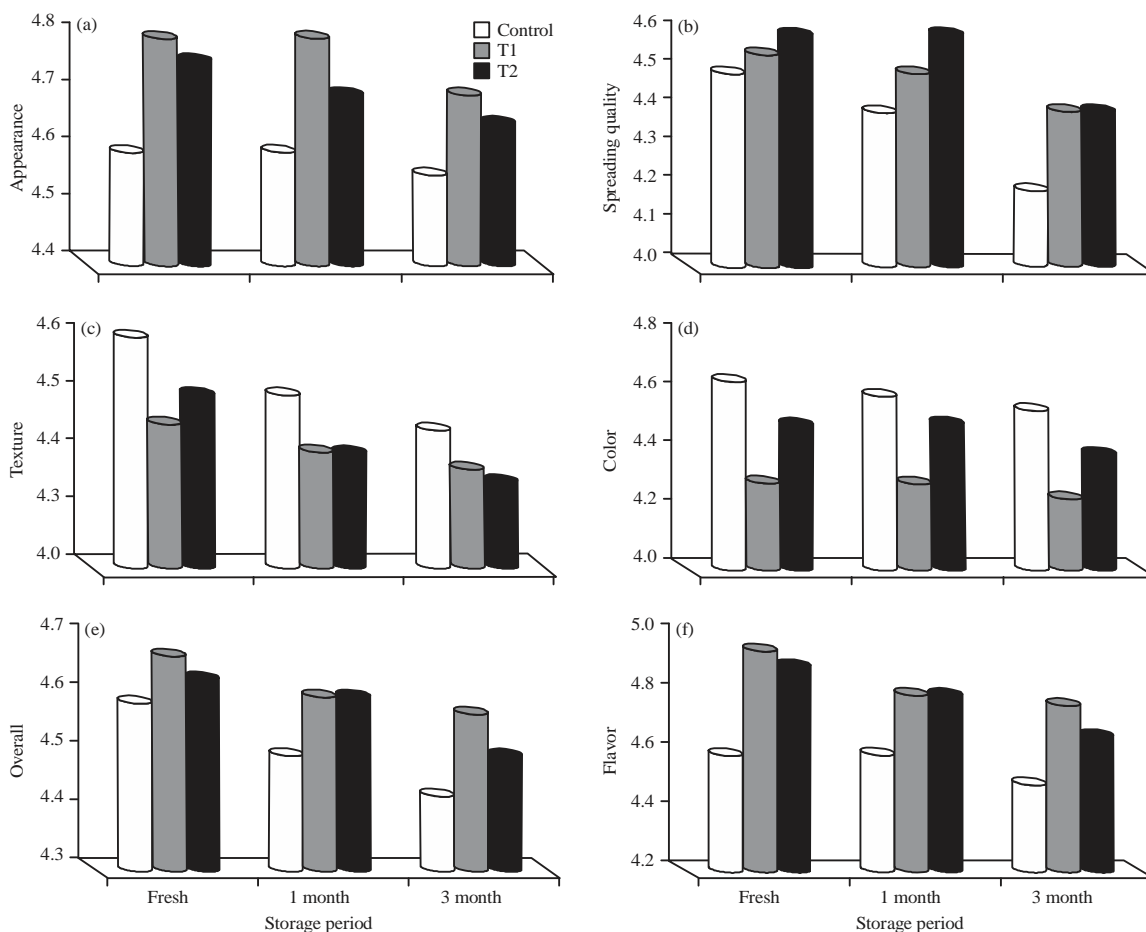


Fig. 4(a-f): Organoleptic evaluation of processed cheese spreads samples fortified with kaki fruit

C: Control, T1: Sweet samples with 20% kaki+12% sugar, T2: Salt samples with 20% kaki+5% salt

in the control rather than kaki-fortified samples. Where,  $L = 100$  means the greatest whiteness while  $L = 0$  means complete darkness. The stimulus (a) in control fresh samples was -2.68 while the corresponding values for salted and sweetened samples were 73.8 and was 16.13, respectively. This indicated that kaki supplemented cheese samples were not clearly white but had slight red color. The data of (A and B) stimuli (which expressed the degree of color), confirmed this result. Where the fortified processed cheese samples color reflected the kaki yellow-red color. The noteworthy that the color of all samples was not greatly affected by storage.

#### Rheological properties of processed cheese spread samples (PCSs) samples:

The texture of PCSs showed clear hardness and gumminess in salted samples compared to control and sweetened samples while cohesiveness and springiness showed opposite trend (Fig. 3). Previous studies showed an increase in hardness and decrease in cohesiveness,

springiness, gumminess and chewiness values in PCSs made by Quinoa fruit and these differences were parallel to the used-ratio of Quinoa<sup>8</sup>.

#### Organoleptic properties of processed cheese spread (PCSs) samples:

It could be observed that fresh sweetened samples (T1) gained the highest scores for appearance, flavor and overall acceptability. However, it had low degrees in color, texture and spreading quality (Fig. 4). Also, it was observed that the acceptability of all samples reduced with storage till 3 months except T1 still have high scores.

#### CONCLUSION

The present study revealed that it could be prepared sweetened processed cheese spreads samples by using kaki fruit suitable for children and hypertension people. The samples seemed to have acceptable properties and delicious taste.

This study discovered that it can be beneficial for individual peoples to consume low sodium cheese among their diets and this study will also help the researchers to uncover the shortage of dairy product in iron and fibers and antioxidants compounds.

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