



**THE EFFECTS OF CITREM EMULSIFIER ON THE TEXTURE AND DURABILITY
OF TOFFEE**

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ABSTRACT

Improving the quality of toffee as a common confectionery product, economically and satisfactorily has important role on its consumers. The main components of toffee contain a mixture of sugar, glucose syrup and oil in appropriate proportions which is obtained after baking at high temperatures. The present study was conducted to evaluate the impacts of types and amount of CITREM emulsifier on physicochemical, microbial, textural and sensory properties of toffee. Three treatments with different values of lecithin in three levels of 0.3%, 0.5% and 0.7% were applied for this purpose. Duncan test was used to evaluate mean comparison at level 0.05 using SAS in three replications. Instron was used to assess the hardness of texture in days 7 and 60. The tests of moisture, oiliness, sulfated ash and acid-insoluble ash showed that all samples had a significant deference with control ($p < 0.05$), while there was not a significant difference between total sugar and control ($p > 0.05$). Microbial growth was not observed in all treatments. The textural analysis showed that increasing emulsifier in day 7 reduce hardness ($p < 0.05$). Sensory evaluation indicated that different levels of emulsifier had significant effects on ability of chewing, color, smell and taste ($p < 0.05$). The minimum hardness and maximum value of sensory evaluation was belonged to 0.7 % of CITREM. Hence, samples containing 0.7 % of CITREM was selected as the most appropriate treatment.

Keywords: Toffee, CITREM, Texture, Physicochemical properties, Sensory evaluation

INTRODUCTION

Confectionery products appeal to a lot of people and there are a small number of people that are not interested in eating them. Good feel after eating these products is one of the reasons for their attractiveness. These products are included significant energy and few nutrients (Anonymous, 2013). Confectionery products based on the ingredient are classified into two main groups; the first group is flour confectionery such as biscuits, cakes, cookies and another one is sugar confectionery such as candy, chocolate, toffee etc. (Edwards, 2000). Toffee is one of the edible materials which increasingly varies in form and taste by time and also its technology is in progress. The main components of toffee include sugar, liquid sugar and edible oils inappropriate proportions that the final product is obtained after baking at high temperatures (Habibi Najafi et al., 2009). The texture of toffee is one of the most important physical characteristics that has a significant impact on consumers. Emulsifiers used in food originally are derived from natural proteins, sterols, phosphohydrolase, and many synthetic ingredients (Torabizadeh, 2001). Besides, emulsifier is defined as any active ingredient in the surface which is able to absorb at the level between the oil and water

and is formed by drops but creates the protection mass. The most important factors affecting the quality of toffee texture are the type and amount of its emulsifier. In this regard, some emulsifiers such as citric acid and CITREM can be good alternatives (Whitehurst, 2004). Using the emulsifier as a part of formulation can be effective on some features of toffee such as improving texture, preventing adhesion, and softness. Besides, using emulsifier in formulation causes oil to disperse more than sugar and oil (Edwards, 2000).

There have been various studies on different emulsifiers and their effects. The literature review show that CITREM is effective emulsifiers which have significant impacts on texture, softness, moisture etc. (Rabi Ashkezari et al. 2013 on chocolate; Hedayati&Tehrani, 2012 on cake; Pedersen, 2004 on potato). Plocharski et al., (2006) showed that CITREM has significant effects on textural, quantitative and qualitative characteristics. Prawira (2009) included that the effect of cocoa butter, milk powder and lecithin have improved textural and sensory properties of milk chocolate. Besides, Rahmati &Tehrani (2014) indicated that there was a significant effect on physical and qualitative features of cake using emulsifiers.

The importance of confectionery products in Iran especially in terms of export to the countries of the Persian Gulf and Central Asia is very important. According to the export records, the toffee export of Iran is more than that of the world (0.64% of mean world export) which is twice the vehicle industry (Fatemi & Mortezaei, 2012). Hence, this study has been aimed to evaluate the possibility of toffee production using CITREM emulsifier on texture and durability of toffee.

MATERIAL AND METHODS

1. Materials

- 1.1. Sugar; white granulated sugar was produced from sugar factory of Varamin
- 1.2. Glucose syrup; glucose syrup with dextrose 42 was produced from glucose company of Ardineh
- 1.3. Oil; hydrogenated vegetable oil was produced from Narin company.
- 1.4. Lecithin; liquid lecithin was prepared from Pak company.
- 1.5. CITREM; it was prepared as powder form from Parsbehbod company.
- 1.6. Salt; Salt was bought from Daryani company.

- 1.7. Citric acid; it is prepared from the world company of chemistry.

2. Production of toffee

Ingredients of toffee include sugar (42.41), glucose syrup (40.30), hydrogenated vegetable oil (6.85), water (9.28), salt (0.13), citric acid (0.03) and emulsifier according to table 1. Sugar and water were mixed in mixer, and then citric acid was added stirred to the mixture and stirred for 10 minutes.

The resulting mixture was put in a double chamber boiler included a stir and temperature sensor (because of the importance of temperature control in the production of toffee). Then, glucose syrup, sugar, water, oil and salt were added to the solution and also stirring was continued during the operation.

Subsequently, according to the table (1), CITREM was applied with different weights in the formula. At the temperature of 121 ° C, steam valve was closed and the contents were transferred to cooling stones for 5 minutes at - 10 ° C. After bleaching toffee, white paste was transferred to the relaxation tables. Subsequently, after about 10 minutes, the paste was transferred to the extruder. Finally it was packaged in particular packages (Anonymous, 2012).

Table 1: the studied treatments based on weight percent

Treatments	Information
B1	Toffee including 0.3 % CITREM
B2	Toffee including 0.5 % CITREM
B3	Toffee including 0.7 % CITREM
C	Control including 0.5 lecithin without CITREM

3. Physicochemical tests

3.1. Moisture; moisture content was measured according to the national standard of Iran as No. 711 (Anonymous, 2007).

3.2. Sulfated ash; ash was measured based on national standard of Iran as No. 711 (Anonymous, 2007).

3.3. Acid-insoluble ash; it was measured based on national standard of Iran as No. 711 (Anonymous, 2007).

3.4. Oiliness; it was measured based on national standard of Iran as No. 711 (Anonymous, 2007).

3.5. Total sugar; it was measured based on national standard of Iran as No. 711 (Anonymous, 2007).

4. Microbial tests

4.1. E. coli; it was performed based on national standard of Iran as No. 2395 (Anonymous, 2007).

4.2. Enterobacteriaceae; it was performed based on national standard of Iran as No. 2395 (Anonymous, 2007).

4.3. Molds and yeasts; it was performed based on national standard of Iran as No. 2395 (Anonymous, 2007).

5. Sensory evaluation; traits of smell, taste, ability to chew (tenderness, softness and stickiness), color was evaluated by 11 assessors using 6-point Hedonic test. For this purpose, zero was considered for unacceptable quality, 1 for quality is not satisfactory, 2 for rather satisfactory quality, 3 for satisfactory quality, 4 for good quality and 5 was considered for excellent quality (Larmond, 1970).

6. Assessment of texture

To assess the textural samples of Toffee, Instron made by Rochdale company of England connecting to the computer with Texture Program was used. Probe is a cylinder with a diameter of 15.3 mm which was connected to a sinker of 50 kg. Probe at a speed of 90 mm per minute to a depth of 6 mm, broke in the samples and the results were recorded by the computer (Ahmadnia & Sahari, 2008)

7. Analyses of data

The randomized complete block design and randomized complete design were used for sensory evaluation and chemical tests, respectively. The experiment consisted of three different treatments and three replications were applied to each treatment.

To delete variances arising from differences between assessors (sensory test), each assessor was considered as a block. In case of significant differences among treatments, Duncan test at 0.05 level was used for mean comparison. The data were submitted to SAS (version 2.9.) and also nonparametric Kruskal-Wallis test was used for data obtained from sensory tests.

RESULTS AND DISCUSSION

1. Physicochemical properties

1.1. Moisture

The results of toffee moisture have been shown in table 2. As is seen in the table, B₂ with 0.5 % of CITREM has the maximum moisture, while the minimum value of moisture is observed for M₃ with 0.5 % of lecithin. There were significant differences between control treatment and the treatments including different values of CITREM ($p < 0.05$). According to national standard, moisture more than 8% is unacceptable for toffee (Anonymous, 2007). Moisture in all samples was in acceptable range for toffee (5.46-6.58). The highest value of moisture was obtained in the treatment including CITREM which it is due to the hydrophilic characteristic of CITREM. The moisture in control treatment is less than treatments of CITREM due to the hydrophobic feature of

lecithin. It confirms the results obtained by Ghosh *et al.* (2005).

1.2. Sulfated ash

The results of sulfated ash of toffee have been presented in table 2. The minimum was belonged to B₁ (0.3% CITREM) and B₂ (0.5% CITREM), whereas the maximum was found in treatment C (0.5% lecithin). There was a significant difference between control and other treatments ($p < 0.05$). According to national standard, sulfated ash more than 2% is unacceptable for toffee (Anonymous, 2007). Sulfated ash amount in all samples was in acceptable range for toffee (0.36-0.42). It can be understood that because sulfated ash in all treatments was in acceptable range, it has no significant impact on the sample properties. This result is accordance with those concluded by Rabi ashkezari *et al.* (2013).

1.3. Acid-insoluble ash

The findings of acid-insoluble ash have been observed in table 2. The minimum Acid-insoluble ash was found in B₁ (0.3% CITREM) and B₂ (0.5% CITREM), while the maximum amount was found in C (0.5% lecithin). There was a significant difference between control and other treatments ($p < 0.05$). Based on national standard, acid-insoluble ash more than 1% is unacceptable for toffee (Anonymous, 2007). The amount of

acid-insoluble ash in all samples was in acceptable range for toffee (0.0257-0.0310). It can be understood that because acid-insoluble ash in all treatments was in acceptable range, it practically has no significant effect on the sample properties.

1.4. Oiliness

The oil results have been presented in table 2. The minimum and maximum oil were found in B₁ (0.3% CITREM) and B₂ (0.5% CITREM), respectively. There was a significant difference between control and other treatments ($p < 0.05$). The increase of oil with increasing the amount of emulsifiers is because of the structural features of emulsifiers.

1.5. Total sugar

The findings of total sugar have been shown in table 2. There was no significant difference between control and other treatments ($p < 0.05$). According to national standard, total sugar more than 60% is unacceptable for toffee (Anonymous, 2007). Total sugar in all samples was ranging between 55.21 and 55.72. As is expected, with fixing the effective factors on total sugar (Sucrose, glucose syrup), and adding different amounts of emulsifier to formulation, there is not observed the significant effect on total sugar.

Table 2: Physicochemical properties of the samples

Treatment	Total sugar (%)	Oil (%)	Acid-insoluble ash (%)	Sulfated ash (%)	Moisture (%)
B1	55/60 ± 0/910 a	8/06 ± 0/015 f	0/025 ± 0/002 c	0/36 ± 0/010 c	6/07 ± 1/431 ab
B2	55/210 ± 1/031 a	8/26 ± 0/015 d	0/0263 ± 0/002 c	0/36 ± 0/015 c	6/58 ± 1/131 a
B3	55/513 ± 0/609 a	8/53 ± 0/040 b	0/0277 ± 0/001 bc	0/38 ± 0/025 bc	6/01 ± 0/084 ab
C	55/360 ± 0/764 a	8/24 ± 0/035 d	0/0310 ± 0/001 a	0/42 ± 0/015 a	5/46 ± 0/566 abc

The means with no same letters show that they have significant differences ($p < 0.05$).

2. Microbial characteristics

The results of microbial tests have been presented in table 3. Microbial results were negative in all samples for *E. coli*, Enterobacteriaceae, molds and yeasts, i.e. these microorganisms have no significant growth. One of the reasons of spoiling the food products is the high rate of water activity. If the water activity is less than

0.91, the bacteria will not be able to grow, and this value for fungi is 0.80. Water activity of toffee is in the range of 0.45-0.60 which is acceptable. Besides, we can reduce water activity to the lowest level with different materials such as emulsifiers, preservatives and water-absorbing materials such as sugars (Ergun et al., 2010).

Table 3: The microbial characteristics of studied samples

Treatment	Molds and yeasts	Enterobacteriaceae	E. coli
B1	Less 10	Less 10	Negative
B2	Less 10	Less 10	Negative
B3	Less 10	Less 10	Negative
C	Less 10	Less 10	Negative

3. Textural test of toffee with Instron

3.1. Analysis of texture in day 7

The results of textural tests of toffee in days 7 and 60 have been presented in table 4. There was a significant difference between control and treatments of CITREM ($p < 0.05$). The high amount of sample hardness is optimal in statistical classification which the maximum hardness started from a, while toffee with soft texture is considered as optimal. The lowest values of hardness in day 7 belonged to B₃ (0.7% CITREM), while the highest value was observed in C (0.5% lecithin). Hardness has inverse relation with oil, emulsifier, and distribution of particle size. The difference in emulsifier type and distribution of particle size causes to increase softness. The hardness in treatments of lecithin was twice than that in treatments of CITREM. The results were similar to those obtained by Rabi ashkezari *et al.* (2013); Hedayati&Tehrani(2012); Pedersen *et al.* (2004); plocharski *et al.* (2006); Prawira *et al.* (2009).

3.2. Analysis of texture in day 60

There was no significant effect between control and other treatments of CITREM ($p <$

0.05) in day 60. The highest hardness belonged to C, while the lowest value was found in B₃. Hardness will be increased by time. The hardness of CITREM in days 7 and 60 showed that the changes in samples of CITREM were less than those in other samples. Some studies indicated that moisture is the most important factor on toffee hardness (Habibi Najafi *et al.*, 2009). Samples containing CITREM due to its hydrophilic characteristic have the minimum change and with increasing CITREM the optimal result was obtained. Deformation is one of the disadvantages of toffee. After 60 days maintaining the toffee, samples of CITREM have the lowest deformation. Besides, there was observed the uniform texture and appropriate distribution for samples containing CITREM. It seems CITREM due to its alpha crystal forms a homogeneous and uniform texture. CITREM has features of poly- glycerol polyricinoleate and lecithin, and its performance in improving the texture is twice that of lecithin (Beckett *et al.*, 2009). This issue is clearly indicated by the results of this study (diagram 1).



Figure 1: the study of texture and treatments of the study

Table 4: the analysis of texture in days 7 and 60

Treatment	Hardness (N/day 60)	Hardness (N/day 7)
B1	11/93 ± 0/074 ^d	10/39 ± 0/835 ^c
B2	10/76 ± 0/395 ^e	9/26 ± 0/213 ^c
B3	6/81 ± 0/737 ^g	5/44 ± 0/621 ^d
C	22/51 ± 0/109 ^b	18/10 ± 1/478 ^b

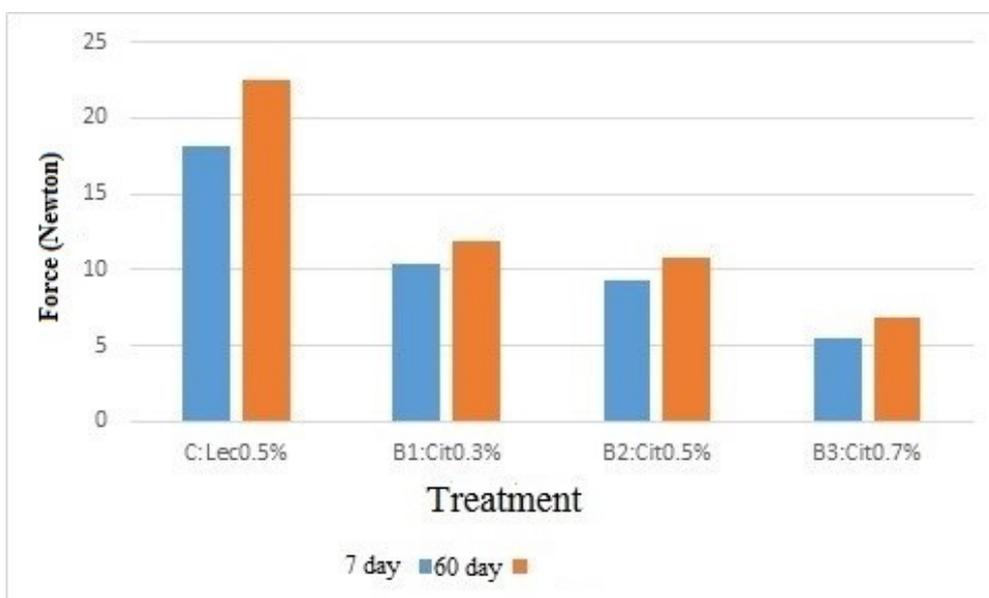


Diagram 1: The comparison of toffee treatments in days 7 and 60

4. Sensory evaluation

4.1. Ability of Chewing (tenderness, softness, stickiness): as is seen by table 5, there was a significant difference between control and treatments of CITREM ($p < 0.05$). The minimum and maximum hardness belonged to B₃ with 0.7 % of CITREM and control, respectively (diagram 2). According

to assessors, the minimum stickiness was belonged to CITREM treatment which it seems due to the high moisture of CITREM. However, the moisture and stickiness have reverse relationship with each other. The results are accordance with those obtained by Rabi ashkezari et al. (2013).

Table 5: The sensory evaluation results of ability to chewing of toffee

Treatment	ability to chewing of toffee in day 60	ability to chewing of toffee in day 30	ability to chewing of toffee in day 7
B1	3/27 ± 0/42 abc	3/33 ± 0/33 abc	3/33 ± 0/61 abc
B2	3/30 ± 0/55 abc	3/36 ± 0/38 abc	3/30 ± 0/35 abc
B3	3/45 ± 0/31 ab	3/52 ± 0/40 a	3/52 ± 0/43 a
C	3/36 ± 0/46 abc	3/27 ± 0/55 abc	3/36 ± 0/31 abc

• Different letters show significant difference (p<0.05)

4.2. Color: as is shown in table 6, there was significant differences of color between treatments of control and CITREM (p<0.05). According to diagram 3, color evaluation in days 7, 30 and 60 shows that the minimum color acceptance was for control, while the maximum was belonged to

B₃ with 0.7 % CITREM. All samples containing CITREM had brilliant color, but increasing the lecithin cause to increase darkness of toffee color. This situation certainly depends on the primary color of emulsifiers. These results confirm the results of Hedayati & Tehrani (2012).

Table 6: the sensory evaluation of toffee color

Treatment	Toffee color in day 60	Toffee color in day 30	Toffee color in day 7
B1	3/97 ± 0/6 ^{ab}	3/79 ± 0/64 ^{abc}	3/88 ± 0/81 ^{abc}
B2	3/94 ± 0/61 ^{abc}	4/00 ± 0/75 ^a	3/88 ± 0/76 ^{abc}
B3	4/00 ± 0/67 ^a	3/97 ± 0/64 ^{ab}	4/00 ± 0/87 ^a
C	3/88 ± 0/79 ^{abc}	3/76 ± 0/72 ^{abc}	3/70 ± 0/85 ^{ab}

4.3. Smell: as is shown in table7, there was significant differences of smell between control and treatments of lecithin, CITREM and their mixture (p<0.05). According to diagram 4, smell evaluation in days 7, 30 and 60 shows that the minimum smell acceptance was for control, while the maximum was belonged to B₁ with 0.3 % CITREM, B₂ with

0.5 % CITREM, B₃ with 0.7 % CITREM. The panelists indicated all treatments of CITREM had pleasant and mild flavor, but samples containing lecithin had oil flavor. Some researchers believe that the oil depends on increasing viscosity and it has no relationship with oil of samples (Rabi ashkezari et al., 2013).

Table 7: the sensory evaluation of toffee smell

Treatment	Toffee smell in day 60	Toffee smell in day 30	Toffee smell in day 7
B1	3/48 ± 0/95 ab	3/70 ± 0/89 a	3/52 ± 1/04 ab
B2	3/61 ± 1/16 ab	3/39 ± 1/11 ab	3/46 ± 1/20 ab
B3	3/52 ± 1/14 ab	3/39 ± 1/12 ab	3/45 ± 1/32 ab
C	3/45 ± 1/09 ab	3/42 ± 1/00 ab	3/42 ± 1/02 ab

4.4. Taste:Asis seenin table8, there was significant differences of smell between control and treatments of CITREM (p<0.05).

According to diagram 4-1, smell evaluation in days 7, 30 and 60 showed that the worst taste was for control and the most appropriate

taste was belonged to B₃ with 0.7 % CITREM. These results are similar to those obtained by Baer *et al.*(1997) on ice

cream;Plocharski et al. (2006) on potato; Prawira et al. (2009) on chocolate.

Table 8: the sensory evaluation of toffee taste

Treatment	Toffee taste in day 60	Toffee taste in day 30	Toffee taste in day 7
B1	3/48 ± 0/48 ^{abc}	3/61 ± 0/25 ^{abc}	3/45 ± 0/27 ^{abc}
B2	3/52 ± 0/23 ^{abc}	3/58 ± 0/42 ^{abc}	3/67 ± 0/33 ^a
B3	3/48 ± 0/27 ^{abc}	3/64 ± 0/38 ^{ab}	3/61 ± 0/39 ^{abc}
C	3/39 ± 0/25 ^{bc}	3/52 ± 0/35 ^{abc}	3/48 ± 0/31 ^{abc}

CONCLUSION

The present study was aimed to evaluate the effects of CITREM emulsifier on physicochemical, microbial, textural and sensory properties of toffee. The results showed that we can produce the appropriate toffee using 0.7 % of CITREM which economically is appealing product for consumers.

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