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Evaluation Of Physico-Chemical Properties, Functional, Organoleptic Characteristics And Sensory Evaluation Of Butter Cake Supplemented With Different Levels Of Jackfruit (Artocarpus Heterophyllus Lam.) Seeds Flour

Amany Ahmed Abd El-Aziz* - Rabab Magdy Esmail**

***Home Economics Department, Faculty of Specific Education, South Valley University, Qena, Egypt**
****Faculty of Education, South Valley University, Hurgada, Egypt.**

Abstract : Background: Cake is one of the most common bakery products consumed by people in the world. It is high in lipid content and caloric value and over consumption amount of it leads to obesity. Jackfruits seed flour (JSF) has high levels in protein and fiber, while low in fat and caloric value. **Objective:** The current study aimed to evaluate the physico-chemical properties, functional, organoleptic characteristics and sensory evaluation of butter cake supplemented with different levels of JSF. **Methodology:** Samples of ripe jackfruit weighed (20-30 kg) were obtained from Agricultural Research Station in Kom Ombo, Aswan Governorate in summer 2015. Seeds were isolated manually and weighed, cleaned, peeled off dried and ground into flour. 10, 15, 20 or 25% of wheat flour (WF) of butter cake formulation were replaced with JSF and compared with control (100% WF). Physico-chemical, functional and organoleptic properties were studied. **Results:** The proximate chemical analysis showed that JSF contained 9.42, 12.14, 1.01, 3.14, 71.2 and 3.09% of moisture, protein, fat, crude fiber, carbohydrate and ash; respectively Protein, carbohydrate and crude fiber of cake content were increased as JSF proportion increased, while fat and moisture were decreased. The functional properties of composite flours were increased with increase in the incorporation of JSF with WF. The organoleptic characteristics results reflected that there was a significant difference in cake that WF was replaced with 15% JSF which was more acceptance than other samples in color, flavor and texture. **Conclusion:** In conclusion, the study showed that the jackfruit seeds

flour powder incorporation with wheat flour could be used to improve the significant improvement physico-chemical properties, functional, organoleptic and sensory characteristics of butter cake.

Key words: Physico-Chemical Properties – functional properties – organoleptic characteristics – butter cake – jackfruit.

Introduction:

Jackfruit is an evergreen tree, producing more yield than any other fruit tree species and bears the largest edible fruit **(Alagiapillai, et al., 1996).** It grows well not only under humid and warm climates of hill slopes, but also in arid plains making it as one of the most suitable fruit crops for dry land horticulture **(Swamy, 1993)**. Jackfruit contains high levels of protein, starch, calcium and thiamine **(Burkill, 1997)**. It is composed of rind, edible bulbs and seeds. Seeds make up around 10 – 15% of the total fruit weight and have high carbohydrate and protein contents **(Ocloo et al., 2010).** Seeds from ripe fruits are edible and are prepared by boiling or roasting, they have a milky and sweet taste **(Morton, 1987)**. Cakes are a confectionary favorite product for Egyptian people and it used in their breakfast or at tea time **(Barakat, 2003),** and are important for delivering bioactive compounds into the human diet (**Alpaslan, and Hayta, 2006 & Villarroel et al., 2006)**. Soft wheat flour is usually considered as good quality flour for soft wheat products such as cakes with a good quality property **(Finney, 1989)**. Functional properties are those intrinsic physicochemical characteristics that govern the behavior of nutrients in foods during processing, manufacturing, storage and preparation as they affect food quality and acceptance **(Eltayeb et al., 2011).** It is further defined as the set of properties that contribute to the desired color, flavor, texture and nutritive value of a product **(Thompson and Edaman, 1981)**; and as any property (except nutritional) of food ingredients, which affect the utilization of foods. Altering level of ingredients and increased in fiber content for the purpose of calorie reduction affected the appearance, flavor and texture of the product. The changed will be noticeable by consumer and thus will influence their preferences on the products **(Nancy and Carole, 1986)**. JSF was good source of fiber which contained high amount of total dietary fiber and crude fiber, and it has been successfully incorporated into bread at level 25% and was accepted by sensory panel **(Hasidah and Aziah, 2003)**. So, the current study aimed to evaluate the

physico-chemical properties, functional and organoleptic characteristics of butter cake supplemented with different levels of JSF.

Materials and Methods:

Materials:

Samples of ripe jackfruit weighed (20-30 kg) were obtained from Agricultural Research Station in Kom Ombo, Aswan Governorate in summer 2015.

Methodology:

Preparation of Jackfruits seeds flour:

Seeds were isolated manually and weighed, cleaned, white arils were peeled off, soaking in 3 percent sodium hydroxide solution for 3-5 minutes to remove brown spermoderm. Seeds were cut into slices, blanched at 70 ºC, dried very well in drying oven at 60ºC for 24 hrs., grinded into powder, sieved and preserved until it was used in physico-chemical, functional and organoleptic properties studied.

Proximate chemical analysis:

All samples were analyzed in triplicate for proximate composition according to **A.O.A.C. (2010)** in Regional Center for Food and Feed laboratory. Protein was carried out using semi-micro kjeldahl according to **A.O.A.C. method No.984.13 (2010)**. For moisture content determination, the samples were dried at 105ºC oven for 12 hrs. For ash content, samples were burnt for 4 hrs, at 550ºC at Muffle furnace. The weight of the remaining residue was used to calculate the ash content. The content of total carbohydrates was determined by difference **(Egan et al., 1981)** according to the formula:-

Total carbohydrates % = 100 – % of (moisture + lipid + protein + ash) on wet weight basis or

Total carbohydrates % = 100 – % of (lipid + protein + ash) on dry weight basis

Physiological properties:

pH value: The pH value was determined by blending 10g of the homogenized sample with 90 ml distilled water **(Kirk and Sawyer, 1991)** and measuring using a pH meter (Model No. pH-8414).

Functional properties:

The functional properties of flours were analyzed as follows:

- **The water and oil absorption capacity (WAC and OAC)**: both water and oil absorption was measured in triplicates according to method described by **Sosulski and McCurdy (1987)**.
- **Bulk density (BD):** bulk density was determined as the method described by **Narayana and Narasinga Rao (1984).**
- **Swelling power (SP):** swelling power % of flour was determined as the method described by **Schoch (1964)**.

Preparation of butter cake:

Butter cake was prepared and baked according to method of **Saba (2003)** in nutrition laboratory, Home Economics Department, Faculty of Specific Education, South Valley University, Qena, Egypt. Butter cakes were divided into five treatments as follow: control butter cake (100% WF), wheat flour was partially substituted by 10, 15, 20 and 25% of JSF. The value addition was done by JSF powder with the incorporating in the WF at a concentration of 10% (90% WF+10% JSF) "A", 15% (85% WF+15% JSF) "B", 20% (80% WF+20% JSF) "C", and 25% (75% WF+25% JSF) "D"; respectively.

Table (1): Basic Recipe for cake formulation

Ingredients	Quantity
Wheat flour (72%extraction) (g)	**200**
Sugar powder (g)	**120**
Butter (g)	**100**
Milk (ml)	**12**
Fresh whole egg (g)	**80**
Baking powder (g)	**8**
Vanilla (g)	**2**
Salt (g)	**1**

All previous ingredients were purchased from the local market, Qena, Egypt.

Organoleptic characteristics:

Cake samples were evaluated organoleptically (height, weight, volume and specific volume) as follows: the weight of cake was determined after cooling for one hour. Cake volume was measured by rape seed displacement method as described by

A.A.C.C. (2002). Specific volume of cake was calculated by dividing the volume (cm^3) by their weight (g).

Sensory evaluation:

The sensory characteristics were evaluated according to **Salem (2011).** 45 untrained panelists from faculty staff members and students of Faculty of Specific Education, South Valley University. Panelists were asked to select the most acceptable samples. The characteristics were scored from 20 points for each according to the method of **A.A.C.C. (2002).**

Statistical analysis:

All determinations were done in triplicate and subjected to statistical Analysis of Variance (ANOVA) by using SPSS version 17.0 (**Pallant, 2005**). The results were expressed as mean±standard deviation and values of $P<0.05$ were considered statistically significant.

Results and Discussion

Physico-Chemical properties:

Proximate chemical composition of WF and JSF are listed in Table (1). JSF was significantly showed the highest percent of protein (10.8%), crude fiber (3.14%) "The fiber content was directly influence the functional properties like water absorption, stabilizing texturizing and thickening capacities **(Kunzek et al., 2002)**" and ash (3.09%), while, WF was significantly showed the highest percent of fats (1.39%) and moisture (12.59%). The lower the moisture content of flour, the better its shelf stability and the quality. Moisture content of flour generally is depended upon the duration of the drying process **(Abraham and Jayamuthunagai, 2014)**. WF scored the highest caloric value (342.31 kcal/100g). Similar finding was obtained by **(Ocloo et al., 2010).** Such results were different with those obtained by **Vanna et al. (2002) & Mohammad et al. (2014) & Shrivastava and David (2015),** the differences in these compositions may be due to varietal reasons as, agro-ecological conditions and methods of analysis.

pH value of WF and JSF were 6.3 and 5.78; respectively The functional properties of dough are affected by pH value,

increasing the pH enhanced the functional properties of the acetylated gluten **(Majzoobi and Abedi, 2014)**.

Table (2): The average of physical properties chemical composition of WF and JSF

Sample	pH	Moisture%	Protein%	Fats%	Crude Fiber%	Ash%	Carbohydrate %	Caloric value kcal/100g
WF	6.3^{a} ±0.26	12.59^{a} ±0.53	10.80^{b} ±0.08	1.39^{a} ±0.02	2.17^{b} ±0.3	1.40^{b} ±0.62	71.65^{a} ±0.03	342.31^{a} ±0.15
JSF	5.78^{b} ±0.66	9.42^{b} ±0.07	12.14^{a} ±0.26	1.01^{b} ±0.21	3.14^{a} ±0.02	3.09^{a} ±0.45	71.2^{b} ±0.36	306.03^{b} ±0.03

Data followed by different letters in the same column are significantly different at $p \leq 0.05$ JSF: jackfruit seed flour WF: wheat flour

Functional properties:

The functional properties of composite flours such as water absorption capacity, oil absorption capacity, bulk density, swelling capacity, foam capacity, and foam stability, were increased with increase in the incorporation of JSF with WF. The water absorption capacity (WAC) of the WF and JSF were 25.7 and 27.4%; respectively, similar finding was obtained by **Ocloo et al. (2010)**. Increasing WAC of JSF than WF may be due to increasing JSF protein content as reported by **Butt and Batool (2010)** who showed that WAC variation in different flours may be due to different protein concentration, whereas, protein has both hydrophilic and hydrophobic nature and therefore they can interact with water in foods. Incorporation of jackfruit seed flour has shown some significant impacts on WAC and OAC. The percentage of WAC% of studied flour samples A, B, C and D were 25.9, 26.1, 26.3 and 26.7%; respectively

Oil absorption is an important property in food formulations because fats improve the flavor and mouth feel of foods **(Adepeju et al., 2011)**. OAC% of WF and JSF were 18.3 and 23.6% resp. similar finding by **Odoemelam (2005)**. As observed from Table (3) the higher percent of JSF in batter the higher OAC percent, where OAC% of Flour of samples A, B, C and D were 18.5, 18.6, 19.0 and 19.2%; respectively, that was may be due to increase JSF protein which was consider the major chemical component affecting of oil absorption capacity as

reported by **Jitngarmkusol et al. (2008) and Eltayeb et al. (2011)**.

As cleared from the same table BD of WF and JSF were 0.35 and 0.69 g/ml; respectively. Increasing jackfruit levels from 10 to 25% significantly increased bulk density of blended samples. Bulk density gives an indication of the relative volume of packaging materials required. It is also important in determining raw material handling and application in wet processing in the food industry **(Ajanaku, et al., 2012)**.

Swelling power (SP) of flours samples increased with increase in the level of incorporation ratio of JSF. SP of flours depends on size of particles, types of variety and types of processing methods or unit operations **(Suresh et al., 2015)**. Data in Table (3) showed that SP in blending samples ranged between 4.47 and 4.55 ml and sample had the highest value "D" 75%WF+25%JSF", whereas, SP of WF and JSF were 4.47 and 4.72; respectively

Table (3): The average of functional properties of WF and JSF

Sample	WAC %	OAC %	BD (g/ml)	SP (ml)
WF	25.7^{c}±0.161	18.3^{c}±2.303	0.35^{d}±0.58	4.47^{c}±028
JSF	27.8^{a}±1.062	23.6^{a}±0.160	0.69^{a}±0.41	4.72^{a}±0.181
A"90%WF+10%JSF"	25.9^{c}±0.113	18.5^{c}±0.008	0.39^{c}±0.088	4.47^{c}±1.212
B"85%WF+15%JSF"	26.1^{bc}±0.23	18.6^{bc}±0.641	0.43^{bc}±1.52	4.51^{b}±0.47
C"80%WF+20%JSF"	26.3^{b}±0.050	19.0^{b}±1.117	0.46^{b}±2.01	4.54^{b}±1.036
D"75%WF+25%JSF"	26.7^{b}±1.211	19.2^{b}±0.089	0.48^{b}±0.53	4.55^{b}±0.881

Data followed by different letters in the same column are significantly different at p≤0.05 JSF: jackfruit seed flour WF: wheat flour WAC: water absorption capacity OAC: oil absorption capacity BD: bulk density SP: Swelling power A: 90% WF+10% JSF B:85% WF+15% JSF C: 80% WF+20% JSF D: 75% WF+25% JSF

Proximate chemical analysis of chemical composition of different butter cake formulations:

Data listed in Table (4) showed the effect of the incorporation of JSF with the WF. There were significant differences for all parameters considered between control butter cake (100% WF) and other cakes at (P<0.05). As observed from Table (4) the proximate values of composite cake increased with

increasing jackfruit seed flour substitution except moisture and fat content. Moisture content of control cake (18.13%) was in high significant difference with other samples; this was may be the increase wheat flour content. On the other hand, protein and crude fiber contents of sample "D" were higher than other samples, and that was a result of high its content of JSF. These results were in agreed with those obtained by **Amin, (2009) and Khan et al., (2016)**.

Table (4): The average of chemical composition of different butter cake formulations

Sample	Moisture%	Protein%	Fats%	Crude Fibers%	Ash%	Carbohydrate %	Caloric value
WF cake	$18.13^{a}\pm0.13$	$6.84^{d}\pm0.07$	$22.39^{a}\pm0.19$	$0.59^{c}\pm0.83$	$0.66^{d}\pm0.28$	$51.93^{b}\pm0.63$	434.4^{a} ±0.33
A	$16.79^{b}\pm0.46$	$7.01^{c}\pm0.33$	$21.38^{b}\pm0.28$	$0.79^{b}\pm0.47$	$1.36^{c}\pm0.42$	52.67^{a} ±0.73	431.1^{a} ±0.89
B	$16.35^{bc}\pm0.23$	$7.16^{b}\pm0.52$	$21.27^{bc}\pm0.27$	$0.85^{b}\pm0.04$	$1.72^{b}\pm0.19$	$52.64^{a}\pm0.27$	430.6^{a} ±0.23
C	$15.96^{c}\pm0.61$	$7.21^{ab}\pm0.06$	$21.18^{bc}\pm0.13$	$1.3^{a}\pm0.66$	$1.81^{b}\pm0.30$	$52.54^{a}\pm0.61$	429.6^{a} ±0.74
D	$15.75^{c}\pm0.34$	7.27^{a} ±0.49	$20.95^{c}\pm0.78$	1.54^{a} ±0.51	2.12^{a} ±0.38	$52.37^{a}\pm0.98$	427.1^{a} ±0.52

Data followed by different letters in the same column are significantly different at $p\leq0.01$
WF: 100% WF A: 90% WF+10% JSF B:85% WF+15% JSF C: 80% WF+20% JSF D: 75% WF+25% JSF

Organoleptic characteristics:

Data in Table (5) showed that height, volume and specific volume in samples "A", "B" and "C" increased by increasing JSF substitution by 10, 15 and 20% than control cake and sample "D". Whereas, sample "B" scored the highest values of it and the mean values of height, volume and specific volume were 5.24 cm, 141.65cm^3 and 2.09 cm^3/g; respectively Volume is important characteristic in the evaluation of cakes and its quality. The volume of a cake is the most important physical quality parameter used for the evaluation of a cake. It is a quantitative measurement and correlates well with dough handling properties, crumb, texture, freshness and technological versatility **(Pomeranz, 1980)**. Those results were in agreement with that obtained by **Khan et al. (2016)**. While, sample "B" were the lowest value of weight (67.48 g). Control cake recorded the

highest value of weight (74.13 g), such result may be due to the increase moisture content which absorb more starch.

Table (5): Mean of organoleptic characteristics of different butter cake formulations

Sample	Height (cm)	Weight (g)	Volume (cm^3)	Specific volume (cm^3)/g
WF cake	5.12^{b}±0.32	74.13^{a}±1.26	135.41^{b}±0.26	1.82^{b}±0.32
A	5.16^{b}±1.01	70.95^{b}±0.91	139.12^{a}±0.05	1.96^{a}±1.34
B	5.24^{a}±0.4	67.48^{c}±1.11	141.65^{a}±0.39	2.09^{a}±0.84
C	5.19^{a}±0.07	69.77^{b}±0.88	141.33^{a}±0.25	2.02^{a}±1.09
D	5.09^{c}±0.41	73.57^{a}±0.33	134.19^{b}±1.11	1.82^{b}±0.62

Data followed by different letters in the same column are significantly different at p≤0.05
WF: 100% WF A: 90% WF+10% JSF B:85% WF+15% JSF C: 80% WF+20% JSF D: 75% WF+25% JSF

Sensory evaluation:

The mean scores for color, flavor, texture, taste and overall acceptability of the cakes are presented in Table (6), the crust crumb of control sample and sample "A" were more bright brown than samples, while deep brown color of crust and crumb was found in sample "D" and recorded the lowest acceptance in preferred color. Sample "B" which consisted of (85% WF+ 15% JSF) recorded the highest acceptance percent among consumer in crust and crumb color. The statistical analysis revealed that there were significant differences (P<0.05) in color between the control cake sample and sample "B".

Also, sample "B" recorded the best texture. Texture for both control sample and sample "A" was same.

On contrast, more poor texture of composite cake was found with more substitution of seed flour in samples "C' and "D" that result may be due to increase crude fiber content.

The overall acceptability of cake showed that sample "B" scored the highest overall acceptability with mean value (19.14%) followed by sample "C", sample "A", control sample then sample "D" which were the lowest overall acceptability. There was significant difference (p>0.05) samples "B" and other samples.

Table (6): Mean panelists acceptance scores for sensory attributes of different butter cake formulations

Sample	Color	Taste	Odor	Texture	Overall acceptability	Sum
Degree	20	20	20	20	20	100
WF cake	$15.3^{c}\pm2.41$	$17.36^{c}\pm3.13$	$18.88^{a}\pm1.91$	$17.68^{b}\pm1.28$	$18.43^{b}\pm0.77$	$87.66^{c}\pm0.41$
A	$15.8^{c}\pm2.62$	$18.09^{b}\pm0.88$	$18.84^{ab}\pm0.76$	$17.68^{b}\pm3.17$	$18.47^{b}\pm2.01$	$88.88^{b}\pm1.03$
B	$18.88^{a}\pm4.09$	$19.3^{a}\pm2.22$	$19.12^{a}\pm3.46$	$18.83^{a}\pm0.63$	$19.14^{a}\pm1.24$	$95.27^{a}\pm2.2$
C	$16.88^{b}\pm2.38$	$18.11^{b}\pm1.61$	$18.43^{b}\pm1.41$	$17.09^{c}\pm2.09$	$18.88^{b}\pm0.91$	$89.39^{b}\pm0.08$
D	$15.06^{c}\pm1.34$	$17.21^{c}\pm2.58$	$18.37^{b}\pm2.44$	$16.56^{d}\pm1.43$	$17.68^{c}\pm2.89$	$84.88^{d}\pm3.28$

Data followed by different letters in the same column are significantly different at $p\leq0.05$ WF: 100% WF A: 90% WF+10% JSF B:85% WF+15% JSF C: 80% WF+20% JSF D: 75% WF+25% JSF

As showed in figure (1) sample "B" achieved the highest sum of total acceptance (95.27%) that were the most preferred ($p>0.05$), followed by sample "C" (89.39%), followed by sample "A" (88.88%), followed by control sample (87.66%) and finally, sample "D" that were the lowest (84.88%).

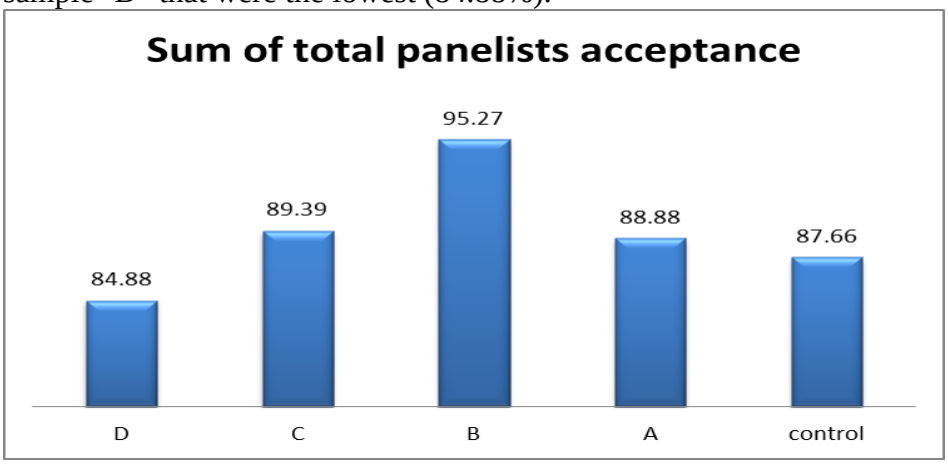

Fig. (1): Sum of total panelists acceptance

Conclusion

Generally, according to this study it could be concluded that the jackfruit seeds flour incorporation with wheat flour has significant affects in improvement physico-chemical properties, functional, organoleptic and sensory characteristics of butter cake. Replacement of 15% of wheat flour with jackfruit seed flour scored the highest acceptance between panelists.

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تقييم الخصائص الفيزيوكيميائية، الخصائص الوظيفية والحسية للكيك الدسم المدعم بنسب مختلفة من دقيق بذور الجاك فروت

أماني أحمد عبد العزيز[١] , رباب مجدي اسماعيل[٢]

مدرس التغذية وعلوم الأطعمة بقسم الاقتصاد المنزلي– كلية التربية النوعية - جامعة جنوب الوادي – مصر[١]
مدرس التغذية وعلوم الأطعمة بقسم المناهج وطرق التدريس – كلية التربية بالغردقة - جامعة جنوب الوادي – مصر[٢]

الملخص :

يعتبر الكيك من أكثر منتجات المخابز استهلاكًا في العالم، وهو يتميز بارتفاع محتواه من الدهون والسعرات الحرارية والتي يؤدي زيادة المتناول منه إلى الإصابة بالسمنة. ويحتوي دقيق بذور ثمار الجاك فروت على نسب عالية من البروتين والألياف الغذائية بينما ينخفض محتواه من الدهون والسعرات الحرارية الهدف: هدفت الدراسة الحالية إلى تقييم الخواص الفيزيوكيميائية والخصائص الوظيفية والحسية للكيك الدسم المدعم بنسب مختلفة من دقيق بذور ثمار الجاك فروت. وقد تم فصل البذور يدويًا ووزنها وتنظيفها وتقشيرها وتجفيفها وطحنها إلى دقيق. المنهجية: تم الحصول على عينات من ثمار الجاك فروت الناضجة والتي يتراوح وزنها (٢٠-٣٠كجم) من محطة البحوث الزراعية بمدينة كوم إمبو بمحافظة أسوان في موسم صيف ٢٠١٥م. وقد تم استبدال دقيق القمح المستخدم في إعداد الكيك الدسم بنسب ١٠، ١٥، ٢٠، ٢٥% من دقيق بذور ثمار الجاك فروت ومقارنة الكيك الناتج بالعينة الضابطة (كيك معد بدقيق القمح ١٠٠%). وقد تم دراسة الخصائص الفيزيوكيميائية والوظيفية والحسية لدقيق بذور ثمار الجاك فروت. النتائج: أظهرت نتائج التحليل الكيميائي لدقيق بذور ثمار الجاك فروت احتوائه على كلا من الرطوبة والبروتين والدهون والألياف الخام والكربوهيدرات والرماد بنسة ٩.٤٢ ، ١٢.١٤ ، ١.٠١ ، ٣.١٤ ، ٧١.٢ ، ٣.٠٩٪ على التوالي. كما أوضحت النتائج زيادة محتوى الكيك الدسم المدعم بدقيق بذور ثمار الجاك فروت من البروتين والكربوهيدرات والألياف الجاف بزيادة نسبة دقيق بذور ثمار الجاك فروت ، في حين انخفضت نسبة الرطوبة والدهن به. وقد أدى زيادة نسبة دقيق بذور ثمار الجاك فروت إلى دقيق القمح إلى ارتفاع الخصائص الوظيفية. وقد أظهرت نتائج الخصائص الحسية أن هناك اختلافا معنويا في الكيك الذي تم استبدال دقيق القمح بنسبة ١٥٪ من دقيق بذور ثمار الجاك فروت والذي كان أكثر قبولا من العينات الأخرى في اللون والنكهة والملمس. الخلاصة: توصي الدراسة باستخدام دقيق بذور ثمار الجاك فروت في المخبوزات حيث أنه يعمل على تحسين الخصائص الفيزيوكيميائية، الخصائص الوظيفية والحسية للكيك الدسم عند نسبة استبدال ١٥% من دقيق القمح.

الكلمات الدالة: الخصائص الفيزيوكيميائية– الخصائص الوظيفية – الصفات الحسية – الكيك الدسم – الجاك فروت.