FJARD VOL. 35, NO. 2. PP. 259-273 (2021)

Fayoum Journal of Agricultural Research and Development
ISSN:1110- 7790

Replacing effect of Jerusalem artichoke flour (*Helianthus tuberosus L.*) instead of margarine on shortened biscuit characteristics

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Abstract

In this work the Jerusalem artichoke flour (JAF) obtained from Jerusalem artichoke tuber (*Helianthus tuberosus L.*) - planted at Fayoum Governorate- was added to biscuit formulas as a substitute percent from 10 ,20, 30, 40,and 50% of the used salt free margarine. Such additive was used due to the nutritional effect of this plant especially that related to the anti-oxidant effect. The study followed the changes resulted in the chemical components, the sensory characteristics and the anti-oxidant activity of the processed biscuits and after storage time up to 90 days.
Due to minimizing the lipids content by JAF replacing the amount of margarine in the formulas, and the final caloric value decreased. Most of the characters were negatively affected specially hardness, texture and the other evaluated items of biscuit. The anti-oxidant activity enhanced due to JAF replacement. In the same time this anti-oxidant activity of biscuit were also effected during storage up to 90 days.

From the findings and the recommendation of the work one could conclude that the more accepted amount of JAF to be added to wheat flour formula was found to be at 30%.

More results also mentioned to the possibility of enhancing most of the biscuit characteristics when the recipe include surplus of water at percent of 5, 10 and 15% regarding the wheat flour used. Such replaced JAF instead of free salt margarine was found to decrease the caloric value of biscuit and to enhance the antioxidant activity which is of good prospect to those consumed such produced biscuit.

KEYWORDS

Biscuit, Wheat flour, Jerusalem artichoke flour, Sensory characteristics, Anti-oxidant activity.

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Received: 7/5/ 2021
Accepted: 9/6/ 2021

1.INTRODUCTION

The subject of using Jerusalem artichoke flour (JAF) or its inulin content to be added to food were followed by many workers due to the nutritional effect of this plant especially what is related to the anti-oxidant effect.

Ozgoren *et al.*, (2019) mentioned that Jerusalem artichoke is considered to be a good source of inulin - like fructans, other dietary fibers, and some minerals, especially potassium.

Many researchers work on the effect of using inulin or JAF on the sensory characteristics noticed in the replaced food.

Luminita Catană *et al.*, (2018) reported that Jerusalem artichoke tubers have antioxidant potential. Due to its complex biochemical composition, the functional ingredient achieved from Jerusalem artichoke tubers can be used to fortify food. Also can be used as a sweetening agent for products destined to diabetics. Studied the antioxidants relation to the JAF components. They noticed that the hardness of biscuit increased when JAF increased. They mentioned that the color and antioxidant activities were improved by JAF due to the acceleration of Maillard reaction by inulin during baking. **Lee *et al.*, (2017).**

Hala and Soha (2017) reported that the texture of biscuit was affected due to increasing level of inulin as a fat re-placer from 10 to 50 % and this serve in the reduction of total lipids and caloric value in all samples of biscuit.

One important direction is the use of JAF as a plant fat re-placer instead of lipids from the animal or poultry sources to minimize the dangerous effect to health of peoples **(Lee *et al.*, (2017).**

The aim of this work is to use JAF at replacement percent from the source of fat i.e. margarine that present in the formula of soft biscuit. Then follow all the changes that occur in the chemical constituents, the appearance and the sensory characteristics of biscuit.

Aggarwal *et al.*, (2016) mentioned that the aftertaste and sweetness of biscuit was affected due to the FOS (fructooligo saccharine sucralose) as fat replacer. Study demonstrated that highly acceptable reduced-calorie biscuits can be produced by using with FOS (as fat re-placer).

Magdalena Krystyjan *et al.*, (2015) noticed the effect on the appearance and texture of biscuit, decreased due to fat reduction. Higher levels of fat replacement could lead to hardness of biscuits.

Norkulova - Karima *et al.*, (2015) discussed the sorption and desorption of water vapor samples of tubers of Jerusalem artichoke.

They mentioned that drying temperature affect the sorption properties of artichoke samples.

Chugh and Kumbhar, **(2013)** worked on the use in the bakery products because of their wide and large consumption around the world.

Laguna *et al.*, (2012) stated that the flavor of biscuit was affected due to fat replaced by a new ingredient .The results showed that the fat replacement increased the hardness and crumbliness.

Cauvain and Young, (2008) studied the contribution of water during processing, baking, cooling and freezing

and the effects of water on product textural properties and their changes during storage on biscuits and pastries the formation of a gluten structure in most biscuits, biscuits and short pastries is limited.

Sudha *et al.*, (2007) referred to the chewiness characteristic and the increase in hardness of the biscuit when the fat level in the biscuit decreased and consequently increased dough toughness and extrusion time of the biscuit dough and the fat reducing effect had a negative effect on the texture of the biscuit.

Manley (2001) classified the basis on enrichment of the recipe as technologists to be useful to the categories biscuits from their external and internal appearance as this helps in deciding the likely recipe and means for forming and baking. It was therefore thought that by calculating the new effective volume of water as a result of the sugar dissolving in the dough perhaps, a better correlation between dough water and fat content could be found.

2.Materials and Methods

Materials.

- **Wheat flours:** Wheat flour (72% extraction) was obtained from Middle Egypt Flour Mills Co. at Fayoum Governorate, Egypt.
- **Jerusalem artichoke Flour (JAF)**: The JAT harvested in December 201٩-20٢٠., JAP was obtained by tuber washing, slicing, citric acid treatment, drainage, drying, milling and sieving through sieve No. 60 (60 mesh/inch).
- **Other components:** The free salt margarine, fresh egg, icing sugar, vanillin are purchased from the local market at Fayoum Governorate, Egypt according to their stander specifications.

Methods.

- Chemical composition.

- Moisture content:

The samples were heated under specified condition and the loss of weight is used to calculate the moisture content of the sample. According to **Norkulova Karima Tuxtabayevna and Safarov Jasur Esirgapovich (2015) and Nielsen, (2010), (AOAC, 2015).**

- Lipids content:

Lipids content was determined using **Soxhlet** extractor and according to **Carpenter, (2010).**

- Protein content:

Protein content was determined using **Kjeldahl** method and according to **Chang, (2010).**

- Ash content:

Ash content was determined according to method explained in **Marshall, (2010)** and **(AOAC, 2015).** International has several dry ashing procedures (e.g., **AOAC** Methods 900.02 A or B, 920.117, 923.03) for certain individual foodstuffs.

- Crude fiber content:

Crude fiber content was determined by following the method according to **AACC, (2000).**

- Total carbohydrates content:

Total carbohydrates were determined according to (**AOAC, (2015)** Method 44.1.30).

- Peroxide value:

Peroxide value was determined as milli-equivelant peroxides per kilogram of fat according to the method described in **AOAC (2015).**

- Antioxidant activity (DPPH):

The method consisted of spectrophotometric measurement of the acuity of the color change in solution depending on the amount of **2, 2-diphenyl- 1-picrylhydrazyl (DPPH)**.

The anti-radical power (ARP) of extracts calculated as **Luminita Catană *et al.*, (2018).**

- Calories estimation: The caloric value estimation was based on: one gram fat gives 9 calories, one gram carbohydrate or protein gives 4 calories **(FAO&WHO 2007)**.

- Biscuits making.

- Preparation of dough and biscuits

Biscuit was prepared as in the method described by **(A.A.C.C, 2000)** using the following formula:

The control biscuits were formulated with 250 g WF, 80 g icing sugar, 110 g salt-free margarine and 20 g egg. The dough was shaped into cylindrical discs with 5 cm diameters and 0.5 cm thicknesses, and then baked at 180 °C for 10 min. After cooling for one hour, the biscuits were packed and used for determinations of chemical, antioxidants and sensory characteristics.

Table 1. Ingredients of biscuit making.

Ingredients	250 gm. flour	100 gm. flour	% From total
Wheat flour	250	100	49%
Fresh eggs +Vanillin 0.5%	20	8	4%
Margarine	110	44	21.5%
Icing sugar	80	32	15.5%
Water	50 ml	20 ml	10%
Total	510	204	100%

- Biscuit treatments.

Treatments with JAP as a fat replacement were done as appeared in Table (2).

Table 2. Treatments and formula of addition Jerusalem artichoke powder (JAP) as a fat replacement to biscuits components.

Components Treatment N0.	JAP %	Wheat flour	Margarine Salt-free	JAP	Sugar (Icing)	Egg+ vanillin	Water
Control	(C)	100	44.00	00	32	8	——
1	C+10% JAP	100	39.60	4.4	32	8	——
2	C+20% JAP	100	35.20	8.8	32	8	——
3	C+30% JAP	100	30.80	13.2	32	8	——
4	C+40% JAP	100	26.4	17.6	32	8	——
5	C+50% JAP	100	22.0	22.0	32	8	——
6	C+30% JAP +10 ml water	100	30.80	13.2	32	8	10 ml
7	C+30% JAP +15 ml water	١٠٠	30.80	13.2	٣٢	٨	15 ml
8	C+30% JAP +20 ml water	100	30.80	13.2	32	8	20 ml

- Sensory evaluation method:
Acceptability and sensory evaluation test score for biscuit according to the following ascending score from 1 to 10.

At least 7 judges from the Faculty of Agriculture, Food Science Department, Fayoum University, are asked to rank the sensory evaluation test according to **San José *et al.*, (2017).**

Table 3. Acceptability of sensory evaluation test.

1 = Extremely unacceptable	6 = Slightly acceptable
2 = Very much unacceptable	7 = Moderately acceptable
3 = Moderately unacceptable	8 = Very much acceptable
4 = Slightly unacceptable	9 = Extremely acceptable
5 = Neither acceptable nor unacceptable	10 = Very extremely acceptable

- Statistical Analysis was done according to the results of organoleptic evaluation were statistically analyzed according to the method described by **Snedecor and Cochran (1967).**

Results and Discussion

Effect of replacement JAP on chemical composition of biscuits.

From **Table (4)** it appears that:

Moisture content: the moisture content for the different biscuit samples with fat replacement ratios: Control, JAP 10%, JAP 20%, JAP 30%, JAP 40%, JAP 50% was found to be 3.44, ٣,٥٧, ٣,٧١, ٤,٤٦, 4.69 and 5.28% respectively. These results are in agreement with **Lee, *et al.*, (2017).**

Table 4. Effect of fat replacement with JAP on the chemical composition of baked biscuits*.

Determinations Treatments	Moisture content%	Fat %	Carbohyd-rate %	Protein%	Ash %	Crude fiber %	Caloric value K Cal/100 g
Control (C)	3.44	21.52	67.14	6.91	0.41	0.85	489.88
C+10% JAP	3.57	19.51	68.32	6.95	0.42	1.23	475.87
C+20% JAP	3.71	17.10	70.32	6.97	0.45	1.45	463.06
C+30% JAP	4.46	15.25	71.51	6.78	0.43	1.57	450.41
C+40% JAP	4.69	14.20	72.22	6.85	0.42	1.62	444.08
C+50% JAP	5.28	12.75	73.12	6.73	0.44	1.68	434.15

***On dry wt.**

Crude protein: the protein content for the different biscuit samples with fat replacement ratios: Control, JAP 10%, JAP 20%, JAP 30%, JAP 40%, JAP 50% was found to be 6.91, ٦,٩٥, ٦,٩٧, ٦,٧٨, ٦,٨٥ and 6.73% respectively. These results are in agreement with **Ozgoren *et al.*, (2019).**

Crude fat: the crude fat for the different biscuit samples with fat replacement ratios: Control, JAP 10%, JAP 20%, JAP 30%, JAP 40%, JAP 50% was found to be 21.52, ١٩,٥١, ١٧,١٠, ١٥,٢٥, ١٤,٢٠ and 12.75 % respectively. These results are in parallel with **Magdalena Krystyjan *et al.*, (2015)**

Carbohydrates: the carbohydrates for the different biscuit samples with fat replacement ratios: Control, JAP 10%, JAP 20%, JAP 30%, JAP 40%, JAP 50% was found to be 67.14, ٦٨,٣٢, ٧٠,٣٢, ٧١,٥١, ٧٢,٢٢ and 73.12 % respectively. These results are in agreement with **Rubel *et al.*, (2014).**

Crude fiber: the crude fiber for the different biscuit samples with fat replacement ratios: Control, JAP 10%, JAP 20%, JAP 30%, JAP 40%, JAP 50% was found to be 0.85, 1.23, ١,٤٥, ١,٥٧, ١,٦٢, and 1.68% respectively. These results are in according with **Ajila *et al.*, (2008).**

Ash content: the crude ash for the different biscuit samples with fat replacement ratios: Control, JAP 10%, JAP 20%, JAP 30%, JAP 40%, JAP 50% was found to be 0.41, ٠,٤٢, ٠,٤٥, ٠,٤٣, ٠,٤٢ and 0.44 % respectively. These results are in agreement with **Magdalena Krystyjan *et al*., (2015)**

Caloric value: the caloric value for the different biscuit samples with fat replacement ratios: Control, JAP 10%, JAP 20%, JAP 30%, JAP 40%, JAP 50% was found to be 489.88, ٤٧٥,٨٧, ٤٦٣,٠٦, ٤٥٠.٤١, ٤٤٤.٠٨ and 434.15 respectively. These results are in agreement with **Cheng *et al*., (2020).**

Table 5. Changes in moisture content % in different biscuits during storage up to three months.

Months / Treatments	Moisture % of biscuits 0- month	1 - month	2 - months	3 - months
Control	3.40	3.45	3.84	4.24
C+10% JAP	3.57	3.70	4.16	4.33
C+20% JAP	3.71	3.82	4.32	4.52
C+30% JAP	4.46	4.61	4.98	5.27
C+40% JAP	4.69	4.77	5.17	5.49
C+50% JAP	5.28	5.49	5.86	6.19

-Moisture content of biscuits.

From **Table (5)** it appear that the moisture content during storage up to three months for the different biscuit samples with fat replacement ratios: for the control, JAP 10%, JAP 20%, JAP 30%, JAP 40%, JAP 50% was found to be 3.40, ٣,٥٧, ٣,٧١, ٤,٤٦, 4.69 and 5.28% respectively. After one month 3.45, ٣,٧٠, ٣,٨٢, ٤,٦١, ٤,٧٧ and 5.49 respectively. After two months: 3.84, ٤,١٦, ٤,٣٢, ٤,٩٨, ٥,١٧ and 5.86 respectively. After storage 3-months: 4.24%, ٤,٣٣%, ٤,٥٢%, ٥,٢٧%, ٥,٤٩% and 6.19% respectively. These results appear that moisture increase with addition of JAP and this could be related to the high absorption of the JAP constituents to water .This direction are in parallel with what stated by **Chowdhury *et al*., (2012).**

The moisture content of biscuits has shown an increasing trend during the three months of storage. During the first month, no marked increase in moisture content was observed for biscuits. But during the second month, moisture gain for these samples was much higher. In the third month, the increase was small compared to second month. In comparison with the initial values of moisture content of biscuits. However, the rate of moisture gain from environment was not same for all biscuits. These results are in agreement with **Cauvain and Young (2008).**

Prolonged exposure of the product to many ambient storage conditions can lead to the absorption of water from the

atmosphere to the biscuit and this serve for this uptake of water .It is therefore common to seal biscuits in a moisture impermeable film to prevent this moisture uptake. As biscuits absorb moisture from the atmosphere they lose their crispness, and become soggy **(Manley, 2001)** and less acceptable to most consumers.

-Effect of JAP on the biscuits general appearance.

The surface color of biscuits is an important quality associated with flavor, texture, and appearance characteristics that are important to consumers and is often used as an indicator of baking completion .

During baking, the fructan chains of inulin in JAP were degraded; leading to the formation of new low-molecular weight products on the crusty surface, and eventually, the Millard reaction of the crust of baked goods could be accelerated**.**

The changes in color and degree of browning showed a positive influence due to the addition of JAP and demonstrated that JAP can be used to improve the consumer acceptance of flavor and color these results agree with what stated by **(Isleroglu *et al*., 2012).**

4.5. Antioxidants activities of flours and biscuit:

Table 6. Antioxidant activities of wheat flour and Jerusalem flour.

Samples		(DPPH) Antioxidant activity(%)			
		Zero time	1 month	2 Months	3 Months
Flour	*Wheat Flour	25.6^{a}	24.9^{b}	24.2^{c}	22.6^{d}
	**Jerusalem artichoke powder	46.7^{a}	44.5^{b}	43.7^{c}	40.3^{d}

***WF = wheat flour.**

****JAP = Jerusalem artichoke powder.**

Table 7. Antioxidant activities of biscuit during storage up to three months.

Storage Time / Treatments	DPPH Antioxidant activity (%) Zero time	1 Month	2 Months	3 Months
Biscuit Control (C)	7.5^{t}	7.3^{tu}	7.1^{u}	6.8^{w}
C +10 % JAP	1٥.3^{p}	13.2^{q}	9.8^{r}	7.8^{s}
C +20 % JAP	2٧.6^{i}	22.4^{l}	17.4^{n}	16^{o}
C +30 % JAP	3٢.3^{e}	26^{j}	21.4^{m}	17.4^{n}
C +٤0 % JAP	3٨.2^{b}	32^{f}	28.6^{h}	25.6^{k}
C +50 % JAP	41.1^{a}	36^{c}	33.2^{d}	31.5^{g}

C = Control biscuit without JAP.

From **Table (6)**, an increase in % antioxidants activity for JAP (JAP) was 46.7%, while wheat flour was 25.6%. In case of biscuit the antioxidant activity from **Table (7)** the control biscuits had 7.5%, and C + JAP10 was

15.3%, and antioxidants increased with an increase in the fat replacement percentage (C+JAP20, C+JAP30, C+JAP40 and C+JAP50) which showed 27.6%, 32.3%, 38.2% and 41.1%, respectively. This increase in the antioxidant activity could is explained to the high level of antioxidant activity in the added JAP as mentioned by **Lee, *et al*., (2014).**

The antioxidant activities after storage of biscuits were lower than those of flours because other mixed ingredients, such as egg, margarine, and sugar, have low antioxidant levels. The biscuits with JAP showed higher antioxidant activities than those with WF. These results are in agreement with **Ozgoren *et al*., (2019).**

4.6. Sensory evaluation of biscuits.

Data in Table **(8)**: show the scores for the effect of replacement level of JAP on biscuits characteristics.

Appearance: The scores changed form 8.80, 8.50, 8.15, 7.70, 7.40 and 6.65 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, C+40% JAP and C+50% JAP respectively. These results in general are in agreement with what stated by **Magdalena Krystyjan *et al*., (2015)**.

Texture: The scores show according to **Table (8)** for this character 8.45, 8.10, 7.80, 7.15, 6.35 and 5.60 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, and C+ 40% JAP and C+50% JAP respectively. These results in general are in parallel with what stated by **Hala Sayed and Soha Khalil (2017)**.

Color: The scores show according to **Table (8)** for this character 8.95, 8.60, 8.05, 8.00, 7.85 and 6.60 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, and C+ 40% JAP and C+50% JAP respectively. These results in general are in agreement with what stated by **Ozgoren *et al.*, (2019).**

Chewiness: The scores show according to **Table (8)** for this character 8.90, 8.60, 8.00, 7.55, 7.45 and 6.55 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, and C+ 40% JAP and C+50% JAP respectively. These results in general are in parallel with what stated by **Sudha *et al*., (2007).**

Sweetness: The scores show according to **Table (8)** for this character 9.10, 8.30, 8.15, 7.85, 7.35 and 6.65 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, and C+ 40% JAP and C+50% JAP respectively. These results in general are in agreement with what stated by **Vitali *et al*., (2009).**

Tenderness: The scores show according to **Table (8)** for this character 8.65, 8.15, 7.90, 6.95, 6.85 and 5.60 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, and C+ 40% JAP and C+50% JAP respectively. These results in general are in parallel with what stated by **Rezzoug Maache *et al*., (1998).**

Flavor: The scores show according to **Table (8)** for this character 8.90, 8.20, 7.80, 7.70, 7.25 and 7.00 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, and C+ 40% JAP and C+50% JAP respectively. These results in general as what stated by **Laguna *et al*., (2012).**

Aftertaste: The scores show according to **Table (8)** for this character 9.20, 8.50, 8.10, 8.00, 7.80 and 7.35 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, and C+ 40% JAP and C+50% JAP respectively. These results in general are in parallel with what stated by **Aggarwal *et al*., (2016).**

Overall: The scores show according to **Table (8)** for this character 9.20, 8.65,

7.90, 7.70, 7.55 and 6.60 for the Control, C+10% JAP, C+٢0% JAP, C+30% JAP, and C+ 40% JAP and C+50% JAP respectively. These results in general are in parallel with what stated by **Lee *et al.*, (2017)**.

Table 8. Sensory evaluation for biscuit made with different replacement levels of JAP.

Characteristics	Treatment			
	30% JAP + 0ml water	**30% JAP + *5ml water**	**30% JAP + *10ml water**	**30% JAP + *15ml water**
Appearance	7.40^{bc}	7.85^{b}	8.00^{ab}	8.15^{a}
Texture	6.35^{d}	6.70^{c}	7.15^{bc}	7.80^{a}
Color	8.00^{a}	7.90^{b}	7.75^{bc}	7.85^{bc}
Chewiness	7.55^{c}	7.75^{b}	7.65^{bc}	8.00^{a}
Sweetness	7.35^{bc}	7.45^{bc}	8.10^{ab}	8.15^{a}
Moistness	6.95^{d}	7.15^{c}	7.50^{b}	7.90^{a}
Flavor	7.25^{bc}	7.20^{c}	7.45^{b}	7.80^{a}
Aftertaste	7.80^{bc}	8.10^{a}	7.90^{b}	8.00^{ab}
Overall	7.55^{c}	7.65^{bc}	7.75^{b}	7.90^{a}
$\sum$ 90	**66.2**	**67.75**	**69.25**	**٧١,٥٥**

Table 9. Sensory evaluation for biscuit made with replacement level of 30%JAP and with surplus water.

Characteristics	Treatment					
	Control (c)	C+10% JAP	C+20% JAP	C+30% JAP	C+40% JAP	C+50% JAP
Appearance	8.80 ^{a}	8.50 ^{a}	8.15^{ab}	7.70 $^{b c}$	7.40 ^{c}	6.65 ^{d}
Texture	8.45 ^{a}	8.10 ^{a}	7.80^{ab}	7.15 $^{b c}$	6.35 ^{cd}	5.60 ^{de}
Color	8.95 ^{a}	8.60 $^{a b}$	8.05^{bc}	8.00 $^{b c}$	7.85 $^{b c}$	6.60 ^{d}
Chewiness	8.90 ^{a}	8.60 $^{a b}$	8.00^{bc}	7.55 ^{c}	7.45 ^{c}	6.55 ^{d}
Sweetness	9.10 ^{a}	8.30 ^{b}	8.15^{bc}	7.85 $^{b c}$	7.35 ^{cd}	6.65 ^{d}
Tenderness	8.65 ^{a}	8.15 ^{a}	7.90^{a}	6.95 ^{b}	6.85 ^{b}	5.60 ^{c}
Flavor	8.90 ^{a}	8.20 $^{a b}$	7.80^{bc}	7.70 $^{b c}$	7.25 $^{b c}$	7.00 ^{c}
Aftertaste	9.20 ^{a}	8.50 ^{b}	8.10^{bc}	8.00 $^{b c}$	7.80 $^{b c}$	7.35 ^{c}
Overall shape	9.20 ^{a}	8.65 ^{a}	7.90^{b}	7.70 ^{b}	7.55 ^{b}	6.60 ^{c}
$\sum$ 90	**80.15**	**75.6**	**71.85**	**68.60**	**65.85**	**58.6**

***ml water / 100gm wheat flour**

Data in **Table (9):** show the scores for sensory evaluation for biscuit made with replacement level of 30%JAP and with surplus water.

The appearance was enhanced gradually with significant positive differences and these results in general are in parallel with what stated by **Magdalena Krystyjan *et al.*, (2015).**

The texture scores show gradual significant positive differences and these results in general are in agreement with what stated by **San José *et al.*, (2017)**.

The color scores show insignificant negative differences in evaluation due to using surplus water. The more water used the less color density and these results in general are in parallel with what stated by **Hashem *et al.*, (2018).**

The chewiness scores show insignificant positive differences in evaluation value due to using surplus water. The added water serve to increase the showiness

and these results in general are in parallel with what stated by **Sudha *et al.*, (2007).**
The sweetness show a direction to insignificant positive differences in evaluation and these results in general are as what stated by **Vitali *et al.*, (2009).**

The moistness scores show insignificant positive differences in evaluation due to incorporation of water which serve to appear the feeling of moistness and these results in general are in agreement with what stated by **Rezzoug Maache *et al.*, (1998).**
The flavor scores show according to **Table (9)** insignificant positive differences due to surplus of water which serve in mouth buds feel and these results in general are in parallel with what stated by **Laguna *et al.*, (2012).**
The aftertaste scores show insignificant positive differences in evaluation according to **Table (9)** for this character. These results in general are in parallel with what stated by **Mazza (1984).**
The overall scores show insignificant positive differences in evaluation according to **Table (9).** The surplus water enhances all the shape of biscuit and these results in general are in agreement with what stated by **Norkulova- Karima *et al.*, (2015).**
With regard to the effect of using JAP with percent from 10 to 50% as a fat replacer on the different characteristics, the data presented in **Table (8)** show that most of all characteristics showed significant negative effect. The results show also that the severe decline in the biscuit evaluation begin markedly at 40% and 50% level. So one could recommend using replacement levels 10 % to obtain good characteristics, 20% with less evaluation, and also accepted fair evaluation at30% level of replacement.
These results agree with what stated by **Hala Sayed and Soha Khalil (2017)**.
In order to enhance most of the sensory characteristics, mainly that related to texture, tenderness and the other sensory characteristics, surplus water at levels from 5%, 10% and 15% were added to the formula as appeared in **Table (9).**

3.Conclusion

This study showed that the JAP fat replacement in biscuits was possible however, with the increasing fat reduction, the quality factors explicitly worsened .
The total sensory score of biscuits showed that there was not a statistically significant difference between 30% fat substitution and the control sample. At higher (40 and 50%) fat replacement, a small decrease of sensory parameters was observed. These results have a relationship with those for the texture of dough and biscuits.
Fat replacement action in particular decreased taste, aroma and fracture of the products. It happened because the fat present in biscuits influenced their flavor and mouth feel. Its limitation contributed to the increase of the hardness of dough and biscuits, which was confirmed by previous texture analyses.
The maximum level, to which the fat could be replaced with JAP, and at the same time keeping sensory characteristics of biscuits at the comparable level near the control sample, was 20% from the margarine

weight. Above this, the quality factors of the product negatively affected

The study appeared that adding surplus of 15% water regarding wheat flour sample containing 30% JAP as replacement instead of margarine insignificantly improved most of the sensory characteristics of dough and biscuits in comparison of that found in case of using 30% JAP without surplus water .

The replacement of JAP instead of free salt margarine reduced the caloric value of the product due to the fewer calories in JAP in comparison to fat in the margarine.

From the nutritional point the antioxidant activity in the produced biscuit including JAP was also enhanced due to the presence of inulin in the JAP components.

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الملخص العربى

تأثير إستبدال دقيق درنات الطرطوفة كبديل للمارجرين على خصائص البسكويت الدهنى

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- في هذا العمل تم إستبدال دقيق الطرطوفة (JAP) الذي تم الحصول عليه من درنةالطرطوفة إلى مكونات البسكويت الدهنى كبديل للمارجرين النباتي بنسبة (١٠%- ٢٠%- ٣٠% - ٤٠% - ٥٠%).

- تم استخدام هذه المادة المضافة بسبب قيمتها الغذائية وكذلك تأثيرها المضاد للأكسدة.

- تابعت الدراسة التغيرات الكيميائية والخصائص الحسية والنشاط المضاد للأكسدة للبسكويت وبعد فترة تخزين تصل إلى ٩٠ يومًا.

- وقد أوضحت النتائج :

١- أنه بسبب تقليل محتوى الدهون عن طريق إستبدال JAP كبديل المارجرين، انخفضت قيمة السعرات الحرارية النهائية للمنتج .

٢- تأثرت معظم الخصائص سلبًا خاصةً الصلابة والملمس لإنخفاض نسبة الدهن المسؤل عن هذه الخصائص.

٣- حدث زيادة فى النشاط المضاد للأكسدة بسبب استبدال JAP لزيادة المحتوى من الفينولات.

4- تأثر نشاط البسكويت المضاد للأكسدة أثناء التخزين حتى ٩٠ يومًا.

من النتائج وتوصيات البحث الإستنتاج أن الكمية المقبولة من JAP لإضافتها إلى دقيق القمح كانت ٣٠٪. وتم توضيح أيضًا إمكانية تحسين معظم خصائص البسكويت عندما تحتوي الوصفة على كمية من الماءالإضافى بنسبة ٥ و ١٠ و ١٥٪ مقارنة بوزن دقيق القمح المستخدم.

ومن النتائج يمكن التوصية بإستبدال نسبة من دقيق الطرطوفة الى مكونات البسكويت حتى ٣٠% وذلك من وزن المارجرين المستخدم وكذلك إضافة نسبة من الماء حتى ١٥% من وزن دقيق القمح للمساعدة فى التطرية وربط مكونات العجينة.