# American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

OPEN ACCESS American Journal of Food Technology

ISSN 1557-4571
DOI: 10.3923/ajft.2017.201.208

# Research Article
# Chemical and Technological Properties of Improved Snacks from Oat and Date Seeds Composite Flour

[1]Ahmed M.S. Hussein and [1,2]Hatem S. Ali

[1]Department of Food Technology, National Research Centre, Dokki, Cairo, Egypt
[2]Department of Food Science and Nutrition, College of Food Science and Agriculture, King Saud University, Saudi Arabia

## Abstract

**Objective:** The present study aimed to investigate effect of addition date seed powder on the chemical composition, rheological properties, diffraction scanning colorimetric, x-ray diffraction, infra-red (IR), flavonoid, antioxidant activity, total phenolic compounds and sensory evaluation of snack from them. **Methodology:** Raw materials (oat and date seed flour) and snacks were analyzed for their proximate composition, rheological (rapid viscoanalyzer and following number), physical properties, color and texture were subjected to measurements using Differential Scanning Calorimetery (DSC). Each sample was tested for its color, flavor, taste, crispness, appearance and overall acceptability. **Results:** The obtained results revealed that, incorporation of date seed powder resulted in a significant increase in fibre and ash contents and in a decrease in protein content. Increasing DS levels in snacks led to increase the falling number (sec). Addition of date seeds to oat flour decreased the t parameters of RVA such as peak viscosity, trough, breakdown, setback, final viscosity, pasting temperature and peak time. Also, sensory evaluation indicated that, increasing DS levels in snacks led to decrease the sensory scores of color and crispness but in the same time, taste was increased and flavor, appearance and overall acceptability not affected significantly. **Conclusion:** This by-product could be valuable and excellent source for low-priced functional food components, where, snacks characterized by its higher crude fiber, minerals and acceptable sensorial.

Key words: Oat flour, date seed powder, snacks, DSC, RVA, color, sensory evaluation

Received: October 11, 2016 Accepted: February 20, 2017 Published: April 15, 2017

Citation: Ahmed M.S. Hussein and Hatem S. Ali, 2017. Chemical and technological properties of improved snacks from oat and date seeds composite flour. Am. J. Food Technol., 12: 201-208.

Corresponding Author: Ahmed M.S. Hussein, Department of Food Technology, National Research Centre, Dokki, Cairo, Egypt



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

The date has great influence on the national income and life style of the people of various regions of the world. Egypt is considered one of the date producing countries[1]. Based on FAO[2] statistics the world production of dates reaching $9 \times 10^6$ t in 2007, only 960,000 t seeds are produced. Therefore, utilization of such waste is very important to date cultivation and to increase the income to the responsible sector[3,4].

Date pits could be regarded as an excellent source of food ingredients with interesting technological functionality that could also be used in food as an important source of dietary fiber[5,6]. The high concentration of polyphenolic content which act as effective natural antioxidant make the date seeds a promising source for obtaining new, active ingredients and dietary supplements[7].

Chemical composition of date pits showed high amount of fiber, fat, proteins, phenolics and ash. Also, the high level of dietary fiber content makes it suitable dietary supplements. The evaluation of Saudi Mafrood flat breads containing various concentrations of date seed fibers revealed that rheological properties were similar for doughs containing coarse date seed fiber or wheat bran. At concentration of 10% the bread showed high level of dietary fiber compared to control. In contrast the bread had low score of color and sensory evaluation scores[7].

Recently, oats (*Avena sativa* L.) had much attention in human foods due to results of epidemiology studies which revealed its healthy properties[8]. However, the oat flour has several rheological drawbacks[9,10]. Therefore, blend of wheat gluten with oat flour may enhance its applications. Almost one third of total fatty acids present in oats are polyunsaturated which are required for good health. It contains high concentrations of vitamins, minerals and dietary antioxidant compounds. So, it recommended for diabetics and reduction of weight[11].

Nutritious snacks play an important role in providing children as well as adult with the energy and essential nutrients they need for healthy growth and development[12]. Unfortunately most of snacks available in the market either local or foreign, although very attractive in packaging, taste and appearance are very poor in nutritional value[13].

In this context, the present study aimed to investigate effect of addition date seed powder on the chemical composition, rheological properties, diffraction scanning colorimetric, x-ray diffraction, infra-red (IR), flavonoid, antioxidant activity, total phenolic compounds and sensory evaluation of snack from them.

## MATERIALS AND METHODS

**Materials:** Oat flacks, salt, cumin and honey were purchased from the local market, Dokki, Egypt. Date palm fruit was obtained from the Station research and agricultural experiments in Dirab-Faculty of Science of Food and Agriculture, King Saud University.

**Preparation of flours (oat and date-seeds):** Oat flacks was mill in blender brawn to obtain oat flour. The seeds were soaked in water, washed to get rid of any adhering date flesh and then air-dried. Their relative percentage weight compare with the weight of the fresh fruits was about 10.1% for the Sukkari variety. Then, they were further dried at about 60°C. Date stones (also kernels or pits) were separated by milled in a heavy-duty grinder to pass 1-2 mm screens to produce date-pit powder and then preserved at -20°C until analyses. Oat flour was well blended with date-pit powder to produce individual mixtures containing 0, 10, 20, 30 and 40% replacement levels to manufacture of snacks. All samples were stored in airtight containers and kept at 3-4°C until required.

**Rheological properties:** Oat flour blends at 0, 10, 20, 30 and 40% levels were prepared by replacing date-pit powder. The effect of date-pit powder on the mixing profile of the dough was studied using relative viscoanalyzer and falling number according to AACC[14].

**Diffraction Scanning Colorimeter (DSC):** Thermal properties of oat flour, date-pit powder and their mixtures flour mixtures containing 0, 10, 20, 30 and 40% replacement levels date-pit powder were measured by using a shimadzu DSC-50. The heating rate was 10°C $min^{-1}$ and the hold temperature was at 200°C. The melting temperature (TM) and enthalpy (ΔH) was determined from the thermograms.

**Preparation and evaluation of snacks:** Snacks were prepared from oat flour, date-pit powder, honey, salt and cumin. This formula was prepared and mixing with water to produce dough. The dough was prepared, cut into small pieces, spread into thin layers on a tray, cut into flakes then, placed into the oven at 180°C for 4 min. Snacks samples were evaluated for color (20), flavor (20), taste (20), crispness (20), appearance (20) overall acceptability (100) according to the method described in AACC[14].

**Analytical methods:** Moisture, ash, fiber, protein and fat of raw materials and different snacks were determined according

to AOAC[15]. Changes in Hunter color parameter (L, a and b) of raw materials and different snacks were followed up using Tristimulus Color Analyzer (Hunter, Lab Scan XE, Reston, Virginia) with standard white tile.

**Statistical analysis:** The obtained results were evaluated statistically using analysis of variance as reported by McClave and Benson[16].

## RESULTS AND DISCUSSION

**Raw materials composition:** Chemical composition of Oat Flour (OF), Date Seeds (DS) and their blends were determined and presented in Table 1. The obtained results showed that moisture content of selected samples ranged between 7.34-9.48%. The OF characterized by its higher crude fiber (13.58%), fat (5.38%) and total carbohydrate (74.50%) compared to DS. Also, higher fiber content and ash were found in DS. The DS had higher the falling number (302 sec) than OF (220 sec) which agreed with the results of previous studies[17-22].

Table 2 summarized the minerals contents (mg/100 g) of the tested samples. The OF characterized by its higher content in potassium (321), phosphorus (395), iron (3.5), zinc (2.8) and copper (1.30) compared to DS. In addition, DS characterized with its higher calcium content (75 mg/100 g). These results were in agreement with El-Kassas[23] who reported that date seeds are considered as a good source of the macro-elements such as K, P, Ca and Mg.

**Oat and date seeds flour as well as their formulations:** Differential Scanning Colorimeter (DSC) of and their blends from of Oat Flour (OF) and Date Seed (DS) were determined and the results are given in Fig. 1. The flour samples showed overall gelatinization temperature as following: 86.82, 89.89, 80.87, 77.93 and 86.05°C in OF and their blends (OF:DS, 90:10), (OF:DS, 80:20), (OF:DS, 70:30) and (OF:DS, 60:40) samples, respectively. The crystallites with the amylopectin molecule and molecular weight and shape of the whole amylopectin molecule determine the onset of swelling and gelatinization[24].

**Rapid Visco Analyzer (RVA) characteristics of OF and their blends from OF and DS:** The pasting properties of OF, WF and their blends (OF:DS, 90:10), (OF:DS, 80:20), (OF:DS, 70:30) and (OF:DS, 60:40) are summarized in Table 3. The adding of DS to OF led to decreased of peak viscosity, trough (cP), breakdown (cP), setback (cP), final viscosity (cP), pasting temperature (°C) and peak time (min). The peak viscosity, holding strength and the setback viscosity increased as the starch amylose content decreased. Amylose, distribution of amylopectin and lipid contents as well as branch chain had great effect on pasting properties and viscosity of starch pastes[25] (Fig. 2).

Table 1: Chemical composition of raw materials and their mixtures (on dry weight basis)

| Samples | Moisture | Protein | Fat | Fiber | Ash | TC | Falling No. (sec) |
|---|---|---|---|---|---|---|---|
| **Raw materials** | | | | | | | |
| Oat flour | 9.48±0.22 | 13.58±0.36 | 5.38±0.05 | 4.82±0.002 | 1.72±0.003 | 74.50±0.72 | 220±2.8 |
| Date seeds | 8.52±0.26 | 7.84±0.28 | 2.88±0.06 | 12.95±0.04 | 4.01±0.005 | 72.32±0.86 | 302±3.5 |
| **Blends** | | | | | | | |
| (90% OF+10% DS) | 8.95±0.37 | 13.22±0.26 | 5.00±0.11 | 5.35±0.09[a] | 2.05±0.09 | 74.38±1.02 | 230±3.6 |
| (80% OF+20% DS) | 8.52±0.32 | 12.36±0.37 | 4.65±0.26 | 6.50±0.09 | 2.52±0.11 | 73.97±1.11 | 245±2.5 |
| (70% OF+30% DS) | 7.77±0.28 | 11.76±0.41 | 4.10±0.15 | 7.20±0.06 | 2.82±0.03 | 74.12±1.00 | 260±3.0 |
| (60% OF+40% DS) | 7.34±0.45 | 11.15±0.18 | 3.70±0.18 | 8.18±0.01 | 3.12±0.03 | 73.85±0.68 | 280±2.5 |

TC: Total carbohydrates calculated by difference, OF: Oat flour, DS: Date seed

Table 2: Minerals content of oat, date seeds and their blends

| | Minerals (mg/100 g) | | | | | |
|---|---|---|---|---|---|---|
| Samples | K | P | Ca | Fe | Zn | Cu |
| **Raw materials** | | | | | | |
| Oat flour | 321±3.00 | 395±5.0 | 63±2.0 | 3.50±0.10 | 2.80±0.01 | 1.30±0.01 |
| Dates | 90±1.15 | 65±2.0 | 75±3.0 | 2.50±0.03 | 0.15±0.00 | 0.40±0.00 |
| **Blends** | | | | | | |
| (90% OF+10% DS) | 310±2.50 | 390±3.0 | 58±1.0 | 3.35±0.09 | 2.65±0.03 | 1.26±0.001 |
| (80% OF+20% DS) | 300±3.00 | 382±6.0 | 53±0.5 | 3.28±0.07 | 2.50±0.01 | 1.20±0.002 |
| (70% OF+30% DS) | 290±2.50 | 374±4.0 | 48±1.2 | 3.22±0.06 | 2.35±0.01 | 1.15±0.002 |
| (60% OF+40% DS) | 280±1.15 | 368±5.0 | 45±2.5 | 3.00±0.03 | 2.20±0.01 | 1.12±0.001 |

OF: Oat flour, DS: Date seed, K: Potassium, P: Phosphorus, Ca: Calcium, Fe: Iron, Zn: Zinc, Cu: Copper

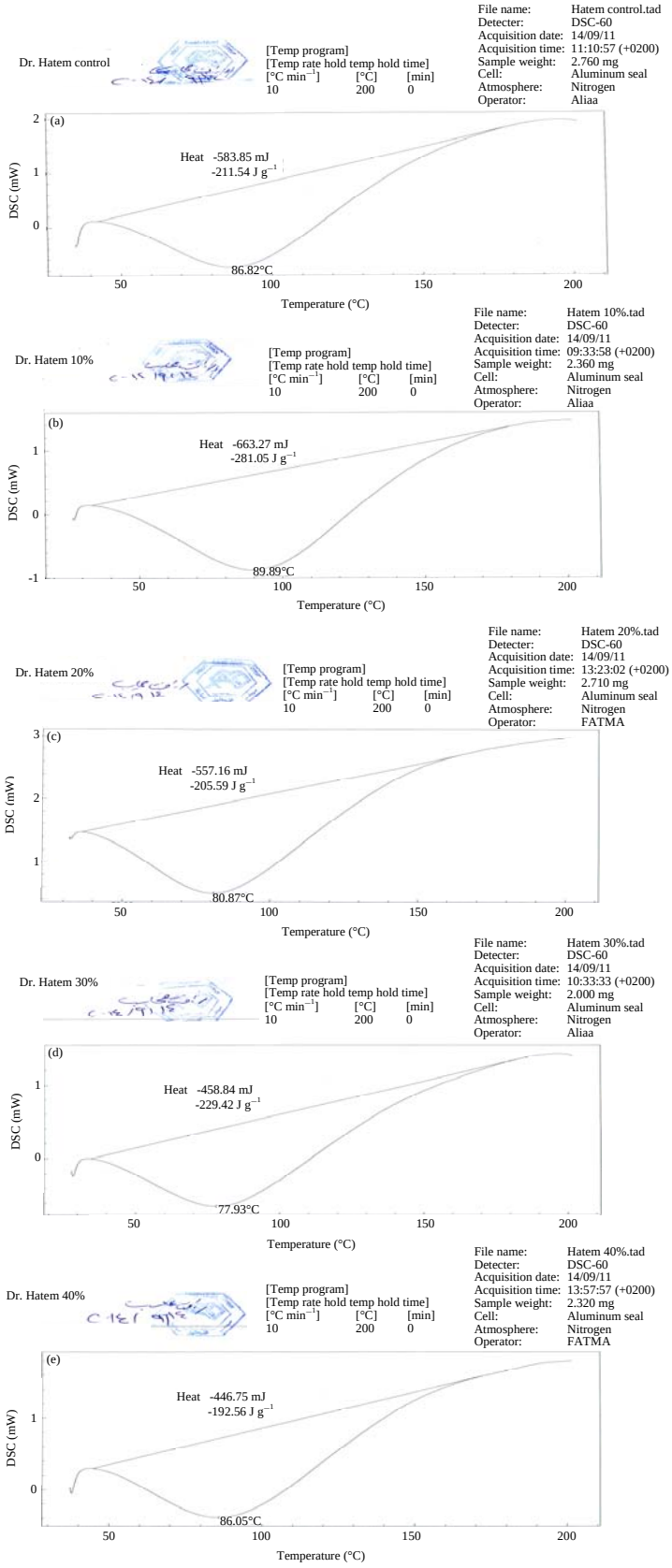


Fig. 1(a-e): DSC of OF and their blends from OF and DS, (a) Control (100% oat flour), (b) 90% oat flour+10% DS, (c) 80% oat flour+20% DS, (d) 70% oat flour+30% DS and (e) 60% oat flour+40% DS

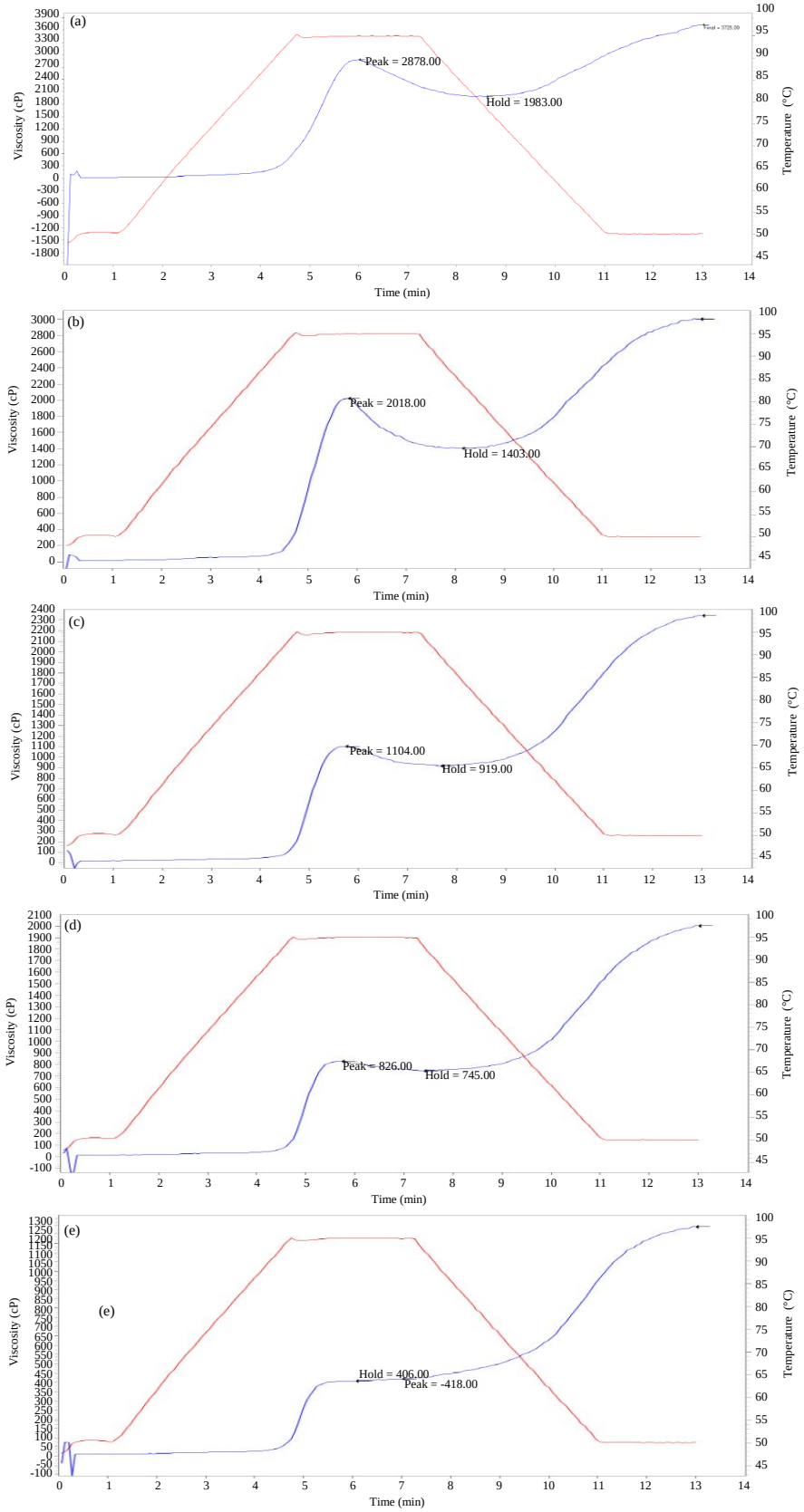


Fig. 2(a-e): Rapid visco-analyzer of OF and their blends from OF and DS, (a) Control (100% oat flour), (b) 90% oat flour+10% DS, (c) 80% oat flour+20% Ds, (d) 70% oat flour+30% DS and (e) 60% oat flour+40% DS

**Color quality:** Data presented in Table 4 show color attributes of snack from OF and their blends from OF and DS. Color parameters of tested samples showed that OF snack was darker than other tested snack samples, where it had the lowest lightness (L = 40.42), redness (a = 8.83) and yellowness (b = 17.61). While lightness (L) value was maximized in snack blend from 80% OF+20% DS (54.90) and ΔE (60.17) then slightly decreased in snack blend from 90% OF+10% DS (53.51). The highest redness (a) value was found in 70% OF+30% DS (11.96) followed by 60% OF+40% DS (11.77) and 90% OF+10% DS (9.70). The highest yellowness value (b) was also found in 90% OF+10% DS (23.21) followed by 80% OF+20% DS (22.82) and 60% OF+40% DS (19.33). This result could be due to the higher polyphenolics and flavonoids compounds and their antioxidant activities in OF and their blends from OF and DS.

**Sensory properties:** Sensory properties of snacks has a great importance to measure consumer acceptability. Therefore, snack samples of OF and their blends from OF and DS were evaluated sensorial are presented in Table 5 and 6. The obtained mean panel score and statistical analysis showed that, snack of 90% OF+10% DS characterized with its higher taste, appearance and overall acceptability (18.4, 18.1 and 89.9), followed by snack of 80% OF+20% DS (18.2, 17.9 and 89.6), 70% OF+30% DS (18.1, 16.2 and 89.0) and OF (17.6, 17.8

Table 3: Pasting profile of oat flour and their blends from oat flour and date seeds

| Treatments | Peak viscosity (cP) | Trough (cP) | Breakdown (cP) | Setback (cP) | Final viscosity (cP) | Pasting temperature (°C) | Peak time (min) |
|---|---|---|---|---|---|---|---|
| Oat flour | 2878 | 1983 | 895 | 1742 | 2330 | 87.15 | 6.00 |
| (90% OF+10% DS) | 2018 | 1403 | 615 | 1600 | 3003 | 91.30 | 5.80 |
| (80% OF+20% DS) | 1104 | 919 | 185 | 1424 | 2343 | 92.60 | 5.73 |
| (70% OF+30% DS) | 826 | 745 | 81 | 1259 | 2004 | 92.70 | 5.73 |
| (60% OF+40% DS) | 418 | 406 | 12 | 832 | 1238 | 94.20 | 7.00 |

OF: Oat flour, DS: Date seed

Table 4: Hunter color parameter of snack from OF and their blends from OF and DS

| | Crust | | | | Back | | | |
|---|---|---|---|---|---|---|---|---|
| Samples | L | a | b | ΔE | L | a | b | ΔE |
| Oat flour | 40.42±0.11$^{f}$ | 8.83±0.05$^{a}$ | 17.61±0.09$^{f}$ | 46.21±0.22$^{d}$ | 45.22±0.22$^{b}$ | 11.57±0.08$^{a}$ | 18.72±0.09$^{d}$ | 50.29±0.65$^{c}$ |
| (90% OF+10% DS) | 53.51±0.15$^{b}$ | 9.70±0.03$^{e}$ | 23.21±0.07$^{a}$ | 59.13±0.36$^{b}$ | 45.48±0.25$^{b}$ | 13.87±0.09$^{e}$ | 21.44±0.07$^{b}$ | 52.16±0.60$^{b}$ |
| (80% OF+20% DS) | 54.90±0.17$^{a}$ | 9.23±0.01$^{f}$ | 22.82±0.06$^{b}$ | 60.17±0.55$^{a}$ | 40.35±0.35$^{c}$ | 11.51±0.03$^{f}$ | 17.57±0.011$^{e}$ | 45.49±0.52$^{d}$ |
| (70% OF+30% DS) | 41.41±0.13$^{e}$ | 11.96±0.06$^{c}$ | 18.23±0.03$^{e}$ | 46.80±0.41$^{d}$ | 49.72±0.19$^{a}$ | 12.00±0.03$^{c}$ | 21.58±0.09$^{a}$ | 55.51±0.25$^{a}$ |
| (60% OF+40% DS) | 45.12±0.22$^{d}$ | 11.77±0.02$^{d}$ | 19.33±0.11$^{d}$ | 50.48±0.39$^{c}$ | 39.38±0.52$^{c}$ | 11.96±0.01$^{d}$ | 17.06±0.11$^{f}$ | 44.55±0.18$^{d}$ |
| LSD at 0.05 % | 0.045 | 0.048 | 0.017 | 0.85 | 1.77 | 0.148 | 0.149 | 0.85 |

OF: Oat flour, DS: Date seed, L: Lightness, a: Highest redness, b: Highest yellowness, ΔE: Total color difference, LSD: Least significant difference

Table 5: Sensory evaluation of snakes produced from OF and their blends from OF and DS with cumin

| Samples | Color (20) | Flavor (20) | Taste (20) | Crispness (20) | Appearance (20) | Overall acceptability (100) |
|---|---|---|---|---|---|---|
| Oat flour | 17.0±0.45 | 16.9±0.66 | 17.6±0.26$^{ab}$ | 16.8±1.03 | 17.8±0.62$^{ab}$ | 86.1±0.48$^{f}$ |
| (90% OF+10% DS ) | 17.6±0.91 | 17.7±0.57 | 18.4±0.35$^{a}$ | 18.1±1.45 | 18.1±0.52$^{a}$ | 89.9±0.72$^{a}$ |
| (80% OF+20% DS ) | 17.7±0.65 | 17.9±0.23 | 18.2±0.49$^{a}$ | 17.6±1.12 | 17.9±0.68$^{ab}$ | 89.6±0.56$^{b}$ |
| (70% OF+30% DS ) | 17.7±0.62 | 18.5±0.64 | 18.1±0.62$^{a}$ | 17.8±1.32 | 16.2±0.42$^{c}$ | 89.0±0.87$^{c}$ |
| (60% OF+40% DS ) | 18.0±0.33 | 18.0±0.89 | 16.9±0.56$^{b}$ | 16.9±1.62 | 16.6±0.56$^{bc}$ | 86.4±0.72$^{e}$ |
| LSD at 0.05 | NS | NS | 01.26 | NS | 1.35 | 0.182 |

OF: Oat flour, DS: Date seed, LSD: Least significant difference

Table 6: Sensory evaluation of snakes produced from OF and their blends from OF and DS with honey

| Samples | Color (20) | Flavor (20) | Taste (20) | Crispness (20) | Appearance (20) | Overall acceptability (100) |
|---|---|---|---|---|---|---|
| Oat flour | 17.2±0.45 | 17.1±0.66 | 17.8±0.26$^{ab}$ | 16.9±1.03 | 18.8±0.62$^{ab}$ | 87.1±0.48$^{f}$ |
| (90% OF+10% DS ) | 17.8±0.91 | 17.9±0.57 | 18.6±0.35$^{a}$ | 18.2±1.45 | 19.1±0.52$^{a}$ | 90.9±0.72$^{a}$ |
| (80% OF+20% DS ) | 17.8±0.65 | 18.1±0.23 | 18.9±0.49$^{a}$ | 17.8±1.12 | 18.9±0.68$^{ab}$ | 90.6±0.56$^{b}$ |
| (70% OF+30% DS ) | 17.9±0.62 | 18.7±0.64 | 19.0±0.62$^{a}$ | 17.9±1.32 | 17.2±0.42$^{c}$ | 90.0±0.87$^{c}$ |
| (60% OF+40% DS ) | 18.2±0.33 | 18.2±0.89 | 17.1±0.56$^{b}$ | 17.0±1.62 | 17.6±0.56$^{bc}$ | 87.4±0.72$^{e}$ |
| LSD at 0.05 | NS | NS | 1.32 | NS | 1.39 | 0.189 |

OF: Oat flour, DS: Date seed, LSD: Least significant difference

and 86.1). Also, snack of OF and their blends from OF and DS with honey gave higher scores in appearance and overall acceptability.

## CONCLUSION

Considering chemical composition, DSC, RVA, color attributes and sensory evaluation of snack produced from OF and their blends from OF and DS with honey or cumin, it could be concluded that these by-product could be valuable and excellent source for low-priced functional food components. The results showed that these snacks characterized by its higher crude fiber, magnesium, potassium and phosphorus. Sensory evaluation showed that snack of 90% OF+10% DS characterized with its higher taste, appearance and overall acceptability, followed by snack of 80% OF+20% DS, 70% OF+30% DS and OF.

## ACKNOWLEDGMENTS

This study was supported by Deanship of Scientific Research at King Saud University. ALL to the members of research group project No. RGP-VPP-032 in Food Sciences and Nutrition Department, College of Food and Agricultural Sciences at KSU also to Food Technology Department, National Research Centre, Dokki, Cairo, Egypt.

## REFERENCES

1. Ahmed, M.B., N.A. Hasona and A.H. Selemain, 2008. Protective effects of extract from dates (*Phoenix dactylifera* L.) and ascorbic acid on thioacetamide-induced hepatotoxicity in rats. Iran. J. Pharmaceut. Res., 7: 193-201.
2. Raman, B.V., A.N.V. Krishna, B.N. Rao, M.P. Saradhi and M.V.B. Rao, 2012. Plants with antidiabetic activities and their medicinal values. Int. Res. J. Pharm., 3: 11-15.
3. Al-Farsi, A.M. and C.Y. Lee, 2008. Optimization of phenolics and dietary fibre extraction from date seeds. Food Chem., 108: 977-985.
4. FAO., 2010. Statistical databases. Food and Agriculture Organization of United Nations, Rome, Italy.
5. Besbes, S., L. Drira, C. Blecker, C. Deroanne and H. Attia, 2008. Adding value to hard date (*Phoenix dactylifera* L.): Compositional, functional and sensory characteristics of date jam. Food Chemist., 112: 406-411.
6. Bouaziz, M.A., H.B. Amara, H. Attia, C. Blecker and S. Besbes, 2010. Effect of the addition of defatted date seeds on wheat dough performance and bread quality. J. Text. Stud., 41: 511-531.
7. Almana, H.A. and R.M. Mahmoud, 1994. Palm date seeds as an alternative source of dietary fiber in Saudi bread. Ecol. Food Nutr., 32: 261-270.
8. FDA., 1997. Food labeling: Health claims; oats and coronary heart disease. Federal Register, 62: 3584-3601.
9. Salmenkallio-Marttila, M., K. Roininen, K. Autio and L. Lahteenmaki, 2004. Effects of gluten and transglutaminase on microstructure, sensory characteristics and instrumental texture of oat bread. Agric. Food Sci., 13: 138-150.
10. Flander, L., M. Salmenkallio-Marttila, T. Suortti and K. Autio, 2007. Optimization of ingredients and baking process for improved wholemeal oat bread quality. LWT-Food Sci. Technol., 40: 860-870.
11. Dykes, L. and W. Rooney, 2007. Phenolic compounds in cereal grains and their health benefits. Cereal Foods World, 52: 105-111.
12. Trumbo, P., S. Schlicker, A.A. Yates and M. Poos, 2002. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids. J. Am. Dietetic Assoc., 102: 1621-1630.
13. El-Shobaki, F.A., I.H. Badawy, Z.A. Saleh and S.G. Gabrial, 2007. Nutritional evaluation of some snacks available in the local market. Egypt. J. Nutr., 11: 101-119.
14. AACC., 2000. Approved Methods of the AACC. 10th Edn., American Association of Cereal Chemists, St. Paul, MN., USA.
15. AOAC., 2000. Official Methods of Analysis of AOAC International. 17th Edn., AOAC International, Gaitherburg, MD., USA., ISBN-13: 9780935584677, Pages: 2200.
16. McClave, J.T. and P.G. Benson, 1991. Statistical for Business and Economics. Max Well Macmillan International Edn., Dellen Publishing Co., USA., pp: 272-295.
17. Pedo, I., V.C. Sgarbieri and L.C. Gutkoski, 1999. Protein evaluation of four oat (*Avena sativa* L.) cultivars adapted for cultivation in the south of Brazil. Plant Foods Hum. Nutr., 53: 297-304.
18. Hamada, J.S., I.B. Hashim and F.A. Sharif, 2002. Preliminary analysis and potential uses of date pits in foods. Food Chem., 76: 135-137.
19. Czubaszek, A. and Z. Karolini-Skaradzinska, 2005. Effects of wheat flour supplementation with oat products on dough and bread quality. Polish J. Food Nutr. Sci., 14: 281-286.
20. Salehifar, M. and M. Shahedi, 2007. Effects of oat flour on dough rheology, texture and organoleptic properties of taftoon bread. J. Agric. Sci. Technol., 9: 227-234.
21. Pastuszka, D., H. Gambus, R. Ziobro, B. Mickowska, K. Buksa and R. Sabat, 2012. Quality and nutritional value of wheat bread with a preparation of oat proteins. J. Microbiol. Biotechnol. Food Sci., 1: 980-987.

22. El Salwa, S.M., A.M.S. Hussein, M.I.A. Moaty, N.H. Ahmed, L.M. Hanna and S.T. Tapozada, 2014. Chemical, rheological and sensory properties of wheat-oat flour composite snacks and its healthy beneficial effect. Int. J. Food Nutr. Sci., 3: 34-43.
23. El-Kassas, F.B., 2004. Utilization of vegetable and fruit processing wastes. Ph.D. Thesis, Faculty of Agriculture, Suez Canal University, Egypt.
24. Tester, R.F. and W.R. Morrison, 1990. Swelling and gelatinization of cereal starches. II. Waxy rice starches. Cereal Chem., 67: 558-563.
25. Gomez, M.H., J.K. Lee, C.M. McDonough, R.D. Waniska and L.W. Rooney, 1992. Corn starch changes during tortilla and tortilla chip processing. Cereal Chem., 69: 275-279.