

*Original Research***Development and Evaluation of Chicken Meat Nuggets Enriched with Date Palm Fruit (*Phoenix dactylifera* L.)****Dipanwita Bhattacharya<sup>\*</sup>, Gurunathan Kandeepan<sup>1</sup> and Pranav Chauhan**

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**Abstract**

A study was conducted to enrich the chicken nuggets with date palm fruit as it is a good natural antioxidant as well as sensory property enhancer. Dried date palm fruits were soaked in boiling water to prepare date palm paste and it was incorporated into chicken emulsion replacing 2.5%, 5% and 7.5% chicken meat to prepare chicken nuggets. A control group of chicken nuggets was made for experiment. Emulsions were stuffed into stainless steel boxes to steam cook for 45 minutes to prepare chicken nuggets. Proximate composition, total phenolics, TBARS, total plate count etc were conducted as quality parameters of chicken nuggets using date palm. 7.5% date palm incorporated chicken nuggets showed less lipid oxidation as TBARS value was lowest  $0.20 \pm 0.004$  and highest total phenolic content of  $0.19 \pm 0.01$ . But 5% date palm incorporated chicken nuggets showed high acceptability in sensory evaluation. Up to 5% level of date palm added chicken nuggets were highly acceptable though 7.5% showed high in phenolic content, higher sweetness and less in lipid oxidation.

**Key words:** Antioxidant, Date Palm, Nuggets, Phenolic Content**How to cite:** Bhattacharya, D., Kandeepan, G., & Chauhan, P. (2018). Development and Evaluation of Chicken Meat Nuggets Enriched with Date Palm Fruit (*Phoenix dactylifera* L.). International Journal of Livestock Research, 8(7), 287-295. doi: 10.5455/ijlr.20170316074748**Introduction**

Fruit and vegetable extracts incorporation in processed meat products provide broad-spectrum health benefits. There is a growing tendency among meat eaters to assimilate sufficient vitamin, mineral, dietary fibre, and phenolic components in meat products. Antioxidant effect of fruits comes mainly because of its polyphenolic compounds in it. Fruits and vegetables used in processed meat industry exhibit functional properties such as water binding, fat emulsification, improving yield and sensory properties (Serdaroglu

*et al.*, 2005). Processed food products contain so many valuable components, such as dietary fibers, pigments, sugars, organic acids, flavors and antibacterial substances (Lario *et al.*, 2004; Ku and Mun, 2008).

Incorporation of antioxidants in the diet has beneficial effects on human health because they protect biologically important cellular components, such as DNA, proteins, and membrane lipids, from reactive oxygen species (ROS) attacks. Fruits in general, are a good of natural source which may protect us against chronic diseases by reducing oxidative damage to biomolecules (Al-Shahib and Marshall 2003; Fu *et al.*, 2011). The date palm (*Phoenix dactylifera Linnaeus*) is an important member of the family Arecaceae (Palmae), providing an essential food for millions of people in the arid and semi-arid regions of the world. Egypt, Iran, Saudi Arabia, South East Spain are gifted with enormous production of dates. In India, commercial cultivation of date is raising day by day. The major date producing states are Rajasthan, Gujrat, Tamil Nadu and Kerala. Though our consumption is very less compared to other countries, we stand in the first position of importing huge quantity of about 4 lakhs tonnes of dates every year. Hababouk, kimri, khalal, besser, rutab and tamar are various ripening stages of dates and during these stages important changes take place in chemical composition including decrease in phenolic substances with increase in sugar concentration (Baliga *et al.*, 2011). Some important health benefits of date are constipation reliever and bowel movement regulator, prevents iron deficiency anaemia, reduces heart disease risk, prevents colon cancer, and traditional medicine as immune system stimulator (Puri *et al.*, 2000; Martín-Sánchez *et al.*, 2013). Extension of processed meat products with date fruits could reduce production costs and improve the nutritional qualities of the products.

Therefore, a study was conducted by incorporating different levels of date palm purée in meat emulsion. This particular study aims to evaluate the effect of date palm purée on physiochemical, microbiological and sensory properties of chicken nuggets prepared from emulsion.

## Materials and Methods

### Raw Materials

Dressed chicken carcasses were procured from Central Avian Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India. Carcasses were packed in clean low density polyethylene (LDPE) bags and quickly brought to the processing plant of Livestock Products Technology Division, IVRI, Bareilly. After proper de-boning, meat was packed in polyethylene bags and stored overnight at  $4 \pm 1$  °C in a refrigerator and then frozen stored at  $-18$  °C till further use. Dried date palms (Tamr stage) were bought from local market of Bareilly. They were soaked (ratio 1:2, palm: boiling water) for 3 min to inactivate fruit enzymes and, after a cooling-down, they were pitted, peeled and blended in a mixer to have the date palm purée.

### Preparation of Chicken Nuggets

Four different meat batters were prepared at different times which included replacement of lean chicken meat with increasing concentration of date palm purée. 2.5%, 5% and 7.5% freshly prepared date palm purée were incorporated in chicken nuggets of T1, T2 and T3 respectively. A control group of nuggets were also prepared following same procedure but without substituting date palm in the formulation. In the processing of chicken nuggets, de-boned lean chicken was minced first then salt, sodium tri-polyphosphate, and sodium nitrite were dissolved in chilled water, then added to minced meat and mixed for 3 minutes at medium speed in bowl chopper. This was followed by addition of oil and chopping for 3 min. condiments, refined wheat flour, dry spices and finally date palm purée were added separately to the mixture which was again mixed for 1 min each for each ingredient. The mixture was removed and stuffed in stainless steel boxes with parchment paper smeared with oil inside and steam cooked for 45 min. Chicken meat blocks so obtained were cooled, sliced and cut into cuboidal pieces to get nuggets.

**Table 1:** Formulation of ingredients for the preparation of control and treatment chicken nuggets (g/100g)

Ingredients (gkg-1)	Control	T-1	T-2	T-3
Lean meat	70	67.5	65	62.5
Date palm	-	2.5	5	7.5
Refined oil	9.5	9.5	9.5	9.5
Chilled water	10	10	10	10
Condiments	3.4	3.4	3.4	3.4
Salt	1.8	1.8	1.8	1.8
Maida	3.2	3.2	3.2	3.2
Spice mix	1.5	1.5	1.5	1.5
STPP	0.5	0.5	0.5	0.5
Sodium nitrite	0.15	0.15	0.15	0.15

STPP: sodium tripolyphosphate; T1-T3: chicken nuggets, where chicken meat was substituted by 2.5%, 5% and 7.5% date palm purée

### Product Analysis

#### Proximate Composition and Microbiological Quality Analysis

Proximate compositions of all the samples were performed on the day following manufacturing of product. Proximate composition of the product such as percentage moisture, fat, protein and ash was determined as per AOAC (1997). The pH was determined by the standard method as outlined by Trout *et al.* (1992) using combined glass electrode of Elico pH meter (Model; LI 127, India). Water activity was measured at 25 °C in a water activity meter (Novasina, TH-500, Axair Ltd., Pfaeffikon, Switzerland). Standard plate counts (SPC) of samples were done on the day of preparation of product as per standardized methods (APHA, 2001).

### Cooking Yield

Cooking yield (%) was calculated and expressed as percentage by the following formula. Percent cooking yield was determined by calculating weight differences for samples before and after cooking (Murphy *et al.*, 1975).

$$\text{Cooking Yield (\%)} = \frac{\text{Weight of cooked chicken nuggets}}{\text{Weight of uncooked chicken nuggets}} \times 100$$

### TBARS

2-Thiobarbituric acid reactive substances (TBARS) were determined on freshly prepared samples (zero day) according to Tarladgis *et al.* (1962). Sample absorbencies were measured with spectrophotometer (Model: Beckman DU 640, USA) at 538nm. Reagents were obtained from Sigma (UK). A conversion factor of 7.8 was used multiplying the OD in the calculation of TBARS. Each sample was analysed in duplicate and results were expressed as 2-thiobarbituric acid reactive substances (TBARS) as mg malonaldehyde (MDA)/kg sample.

### Total Phenolics

Total phenolic content in cooked chicken nuggets from control and date purée incorporated formulations was analysed by using the Folin-Ciocalteu assay (Escarpa and Gonzalez, 2001) with slight modifications. Briefly, five grams of nugget were homogenised with 25 ml of 70% acetone and kept overnight for extraction at refrigeration temperature. Suitable aliquots of extracts were taken in a test tube, and the volume was made to 0.5 ml with distilled water followed by the addition of 0.25 ml Folin-Ciocalteu (1 N) reagent and 1.25 ml sodium carbonate solution (20%). The tubes were vortex mixed and the absorbency was recorded at 725 nm after 40 min.

### Sensory Evaluation

Sensory evaluation of various samples were conducted using an 8 point descriptive scale (Keeton, 1983), where 8 = excellent and 1 = extremely poor. The sensory panel involved ten members selected from scientists and post graduate students of the division of Livestock Products Technology with age between 28–45 years. The panellists were explained about the nature of experiments without disclosing the identity of samples and were asked to rate their preference on 8 point descriptive scale. Samples were warmed in a microwave oven for 1 min. Water was provided to rinse mouth between the samples. The panellists judged the samples for general appearance, binding, colour, flavour, juiciness, and overall acceptability. Sensory evaluation was done in sensory evaluation laboratory of livestock products

technology division of Indian Veterinary Research Institute. Each panellist evaluated three replicates of all the samples at room temperature (Macfie, 1989).

### Statistical Analysis

Three trails were conducted for each experiment with duplicate samples. The data generated for different quality characteristics were compiled and analysed using SPSS (version 20 for Windows; SPSS, Chicago, USA) with variance and least significant difference. Statically analysed results were tabulated and the results were interpreted as in tables.

### Result and Discussion

#### pH

The pH value between control and treatments differed significantly ( $p < 0.05$ ) in Table 2. The pH values decreased significantly ( $p < 0.05$ ) with increasing concentration of date palm in chicken nuggets.

**Table 2:** Physico-chemical and microbiological parameters of date palm purée incorporated chicken nuggets

Parameters	Control	T1	T2	T3
pH	6.44±0.003 <sup>a</sup>	6.19±0.003 <sup>b</sup>	6.17±0.003 <sup>c</sup>	6.17±0.002 <sup>c</sup>
Water Activity	0.98±0.000 <sup>a</sup>	0.97±0.000 <sup>a</sup>	0.97±0.002 <sup>a</sup>	0.96±0.00 <sup>a</sup>
Moisture (%)	65.08±0.004 <sup>d</sup>	65.15±0.009 <sup>c</sup>	65.36±0.21 <sup>b</sup>	66.12±0.02 <sup>a</sup>
Crude Protein (%)	18.33±0.005 <sup>a</sup>	18.28±0.007 <sup>b</sup>	18.07±0.01 <sup>c</sup>	17.69±0.01 <sup>d</sup>
Fat (%)	8.62±0.008 <sup>a</sup>	8.60±0.006 <sup>a</sup>	8.24±0.017 <sup>b</sup>	7.76±0.016 <sup>c</sup>
Ash (%)	2.14±0.009 <sup>d</sup>	2.30±0.01 <sup>c</sup>	2.60±0.008 <sup>b</sup>	2.83±0.02 <sup>a</sup>
Shear Force value (Kg/cm <sup>2</sup> )	0.45±0.006 <sup>a</sup>	0.40±0.005 <sup>b</sup>	0.37±0.004 <sup>c</sup>	0.31±0.007 <sup>d</sup>
Cooking Yield (%)	91.57±0.55 <sup>c</sup>	94.33±0.18 <sup>b</sup>	93.56±0.54 <sup>b</sup>	95.50±0.07 <sup>a</sup>
TBARS (mg malonaldehyde/Kg)	0.29±0.007 <sup>a</sup>	0.26±0.004 <sup>b</sup>	0.25±0.008 <sup>b</sup>	0.20±0.004 <sup>c</sup>
Total Phenolics (mg/GAE 100g)	0.03±.004 <sup>d</sup>	0.08±0.01 <sup>c</sup>	0.16±0.01 <sup>b</sup>	0.19±0.01 <sup>a</sup>
SPC (log cfu/g)	3.24±0.02 <sup>a</sup>	3.05±0.03 <sup>b</sup>	2.90±0.02 <sup>c</sup>	2.68±0.02 <sup>d</sup>

T1-T3: chicken nuggets where chicken meat was substituted by 2.5%, 5% and 7.5% date palm purée; Means with different superscripts (letters row wise) indicates statistical significance  $P < 0.05$ .

But T2 and T3 did not differ significantly ( $p < 0.05$ ). Date palm incorporated chicken nuggets showed lower pH than control which may be due to presence of organic acids in it. It was reported that due to date palm purée addition there was a tendency of lowering in pH for uncooked low fat beef patties (Yıldız-Turp and Serdaroglu, 2010). In another study it was found that chicken nuggets showed a decreased pH due to apple pulp incorporation (Verma *et al.*, 2010). It was reported that date paste contains so many organic acids which lower its pH (Sánchez-Zapata *et al.*, 2011). In another study it was found that pH decreased with enhanced concentration of date paste in pork liver-pate (Martín-Sánchez *et al.*, 2013). Similarly, it was noticed that the pH also decreased for pea incorporation in chicken nuggets (Polizer *et al.*, 2015; AOAC, 1997).

### Water Activity

There was no significant ( $p < 0.05$ ) difference in water activity between control and treatment groups as found in Table 2. Minimal changes were noticed in treatment groups. In treatment groups, reduced values were noticed for water activity ( $a_w$ ). The changes may be due to similar water activity values of date palm and control chicken nuggets. Some workers also did not find any appreciable changes in water activity in control and date paste incorporated chicken nuggets (Martín-Sánchez *et al.*, 2013).

### Proximate Composition

Slight variations were detected in proximate composition between the control and treatment chicken nuggets in Table 2. Moisture content and ash content alleviated significantly ( $p < 0.05$ ) in date purée incorporated chicken nuggets. 7.5% date paste added nuggets showed maximum moisture content. Similarly, protein content and fat content decreased significantly ( $p < 0.05$ ) in treatment groups. Groups with higher moisture content showed the least protein and fat content in treatment groups. A study reported that moisture content was  $66.41 \pm 0.54$  g/100g in date paste (Martín-Sánchez *et al.*, 2013) and in another study a very similar result was obtained in the proximate composition of cooked meat product with date paste (Sánchez-Zapata *et al.*, 2011). Similar study was reported in English breakfast sausages added with different amount of functional ingredients viz. albedo, oat fibre, wheat flour rusk and its combinations (Aleson-Carbonell *et al.*, 2005). A similar result was also obtained in chicken nuggets treated with pea fibre (Polizer *et al.*, 2015).

### Shear Force Value and Cooking Yield

Shear force value decreased significantly ( $p < 0.05$ ) in treatment groups in Table 2. The values decreased slightly between date purée treated groups. Increased tenderness in treatments might be due to presence of organic acids in date fruits and its higher moisture content. A significant ( $p < 0.05$ ) difference was found in cooking yield parameter between control and treatments. Between T1 and T2 there was no significant ( $p < 0.05$ ) difference. T3 showed the highest cooking yield percentage. Increase in cooking yield might be due to water retention properties of fibres in date purée, it was reported that incorporation of fruit fibre and cereals in dry fermented sausage resulted in an increase in cooking yield (Garcia *et al.*, 2002). Similarly, incorporation of fruits and vegetables also increased in cooking yield of meat products (Mehta *et al.*, 2013).

### TBARS

Addition of date palm purée significantly ( $p < 0.05$ ) reduced the TBARS value in treatments compared to control sample in Table 2. The 2.5% and 5% concentration of date paste did not show significant differences whereas, the 7.5% concentration indicated the highest reduction in TBARS value. The result

indicated that active ingredients present in date purée decreased the lipid oxidation which could affect product quality, sensory attributes and nutritional aspects of meat product. It was reported that date palm fruit contains poly-phenolic compounds and flavonoids as antioxidants (Tarladgis *et al.*, 1960). The date palm paste showed reduced TBARS values but they did not differ significantly with control in few studies (Martín-Sánchez *et al.*, 2013). Similar result was obtained when date plum powder incorporated sliced hams showed decreased TBARS values (Nunez *et al.*, 2008).

### Total Phenol Content and SPC

Total phenolic content increased significantly ( $p < 0.05$ ) with increasing concentration of date palm as shown in Table 2. In the microbiological study, standard plate count decreased significantly ( $p < 0.05$ ) in treatment groups when compared to control as in Table 2. It was earlier reported that total phenolic content ranged from 149 to 836 mg of GAE/100 g fresh weight (Nuñez *et al.*, 2009) and some workers also found that date palm paste contains  $225 \pm 22$  mg GAE/100 g fresh weight total phenol content (Sánchez-Zapata *et al.*, 2011). Further, it was also found that date palm fruit showed antibacterial activity for both gram positive and gram negative bacteria (Mansouri *et al.*, 2005; Saleh and Otaibi, 2013).

### Sensory Evaluation

Significant differences ( $p < 0.05$ ) were noticed between control and treatment groups for all sensory attributes listed in Table 3.

**Table 3:** Sensory analysis scores of date palm purée incorporated chicken nuggets

Parameters	Control	T1	T2	T3
Appearance	$7.17 \pm 0.05^c$	$7.37 \pm 0.03^b$	$7.70 \pm 0.04^a$	$7.43 \pm 0.02^b$
Colour	$7.4 \pm 0.03^b$	$7.68 \pm 0.03^a$	$7.75 \pm 0.06^a$	$7.28 \pm 0.03^c$
Flavour	$7.08 \pm 0.03^c$	$7.25 \pm 0.02^b$	$7.6 \pm 0.03^a$	$6.98 \pm 0.03^d$
Juiciness	$7.10 \pm 0.02^c$	$7.25 \pm 0.01^b$	$7.54 \pm 0.02^a$	$7.10 \pm 0.05^c$
Binding	$7.07 \pm 0.00^d$	$7.23 \pm 0.01^c$	$7.30 \pm 0.00^b$	$7.36 \pm 0.00^a$
Overall acceptability	$7.09 \pm 0.00^d$	$7.26 \pm 0.00^b$	$7.51 \pm 0.03^a$	$7.17 \pm 0.03^c$

T1-T3: chicken nuggets where chicken meats were substituted by 2.5%, 5% and 7.5% date palm purée; Means with different superscripts (letters row wise) indicates statistical significance  $P < 0.05$ .

Among them, 5% date palm paste incorporated chicken nuggets got high preference for acceptability. There was no significant ( $p < 0.05$ ) difference in colour between T1 and T2. In case of flavour, T3 showed the least score but for binding it scored highest. Date palm is sweet fruit and sweetness comes from the soluble solids present in it (Sánchez-Zapata *et al.*, 2011) whereas, date fibre might be responsible for high binding. Juiciness was highest in T2 that may be due to increased moisture content. Except flavour, all the sensory parameters showed improved scores in date palm treated meat products compared to control.

Some workers also reported that date purée incorporation enhanced sensory scores in pork liver paste (Martín-Sánchez *et al.*, 2013).

### Conclusion

Date palm purée can be incorporated into chicken nuggets up to a maximum level of 5% without affecting meat product quality attributes. Incorporation at 7.5% level showed increased phenolic content and cooking yield but decreased lipid oxidation, SPC, besides contributing to improved sweetness in the meat product which was viewed as negative factor by the sensory panellists.

### Conflict of Interest

We certify that there is no conflict of interest with any financial organisation regarding the material discussed in the manuscript.

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### References

1. Serdaroglu, M., Yildiz-Turp, G., and Abrodimov, K. (2005). Quality of low-fat meatballs containing legume flours as extenders. *Meat Science*, 70: 99–105.
2. Lario, Y., Sendra, E., García-Pérez, J., Fuentes, C., Sayas-Barberá, E, Fernández-López, J. *et al.* (2004). Preparation of high dietary fiber powder from lemon juice byproducts. *Innov. Food Science and Emerging Technologies*, 5: 113–117.
3. Ku, C.S. and Mun, S.P. (2008). Optimization of the extraction of anthocyanin from Bokbunja (*Rubus coreanus* Miq.) marc produced during traditional wine processing and characterization of the extracts. *Bioresour Technology*, 99: 8325–8330.
4. Al-Shahib, W., and Marshall, R.J. (2003). The fruit of the date palm: Its possible use as the best food for the future? *International Journal of Nutrition and Food Sciences*, 54: 247–259.
5. Fu, L., Xu, B-T., Xu, X.R., Gan, R.Y., Zhang, Y., Xia, E.Q., and Li, H.B. (2011). Antioxidant capacities and total phenolic contents of 62 fruits. *Food Chemistry*, 129: 345–350.
6. Baliga, M.S., Baliga, B.R.V., Kandathil, S.M., Bhat, H.P. and Vayalil, P.K. (2011). A review of the chemistry and pharmacology of the date fruits (*Phoenix dactylifera* L.). *Food Research International*, 44: 1812–1822.
7. Puri, A., Sahai, R., Singh, K.L., Saxena, R.P., Tandon, J.S. and Saxena, K.C. (2000). Immunostimulant activity of dry fruits and plant materials used in Indian traditional medical system for mothers after child birth and invalids. *Journal of Ethnopharmacology*, 71: 89–92.
8. Martín-Sánchez, M.A., Ciro-Gómez, G., Sayas, E., Vilella-Esplá, J., Ben-Abda, J., Pérez-Álvarez, J.A. (2013). Date palm by-products as a new ingredient for the meat industry: Application to pork liver pâté. *Meat Science*, 93: 880-887.
9. AOAC. Official Methods of Analysis of AOAC International.(1997); 16th Edition, ed. By Association of Official Analytical Chemists, Washington, D.C.
10. Trout, E.S., Hunt, M.C., Johnson, D.E., Claus, J.R. and Kropt, D.H. (1992). Characteristics of low fat ground beef containing texture modifying ingredients. *Journal of Food Science*, 57: 19-24

11. APHA. Compendium of methods for the microbiological examination of foods. (2001). edition. American Public Health Association, Washington DC, USA.
12. Murphy, E.W., Criner, P.E, and Grey, B.C. (1975). Comparison of methods for calculating retentions of nutrients in cooked foods. *The Journal of Agricultural and Food Chemistry*, 23: 1153–1157.
13. Tarladgis, B.G., Watts, B.M., Yaunathan, M.T. and Dugan, L.R. 1960. Distillation methods for the quantitative determination of malonaldehyde in rancid foods. *The Journal of the American Oil Chemists' Society*, 37: 66-71.
14. Escarpa, A., Gonzalez, M.C. (2001). Approach to the content of total extractable phenolic compounds from different food samples by comparison of chromatographic and spectrophotometric methods. *Analytica Chimica Acta*, 427: 119–127.
15. Keeton, J.T. (1983). Effect of fat and sodium chloride and phosphate levels on the chemical and sensory properties of pork patties. *Journal of Food Science*, 48: 878-881.
16. Macfie, H.J., Bratchell, N., Greenhoff, K., and Vallis, L. (1989). Designs to balance the effect of order of presentation and first-order carry-over effects in hall tests. *The Journal of Sensory Studies*, 4:129–148.
17. Yıldız-Turp, G. and Serdaroglu, M. (2010). Effects of using plum purée on some properties of low fat beef patties. *Meat Science*, 86: 896-900.
18. Verma, A.K., Sharma, B.D., Banerjee, R. (2010). Effect of sodium chloride replacement and apple pulp inclusion on the physicochemical, textural and sensory properties of low fat chicken nuggets. *LWT - Food Science and Technology*, 43: 715-719.
19. Sánchez-Zapata, E., Fernández-López, J., Peñaranda, M., Fuentes-Zaragoza, E., Sendra, E., Sayas, E., José, A., Pérez-Alvarez. (2011). Technological properties of date paste obtained from date by-products and its effect on the quality of a cooked meat product. *Food Research International*, 44: 2401-2407.
20. Polizer, Y.J., Pompeu, D., Hirano, M.H., Freire, M.T.A, Trindade, M.A. (2015). Development and evaluation of chicken nuggets with partial replacement of meat and fat by pea fibre. *Food Technology*, 18: 62-69.
21. Aleson-Carbonell, L., Fernandez-Lopez, J., Perez-Alvarez, J.A., and Kuri, V. (2005). Functional and sensory effects of fiber-rich ingredients on breakfast fresh sausages manufacture. *Food Science and Technology International*, 11: 89-97.
22. Garcia, M.L., Domingue, Z.R., Galvez, M.D., Casas, C. and Selgas, M.D. (2002). Utilization of cereal and fruit fibers in low fat dry fermented sausages. *Meat Science*, 60: 227-236.
23. Mehta, N., Ahlawat, S.S., Sharma, D.P. and Dabur, R.S. (2013). Novel trends in development of dietary fiber rich meat products-a critical review. *The Journal of Food Science and Technology*, DOI 10.1007/s13197-013- 1010-2.
24. Tarladgis, B.G., Watts, B.M., Yaunathan, M.T. and Dugan, L.R. (1960). Distillation methods for the quantitative determination of malonaldehyde in rancid foods. *The Journal of the American Oil Chemists' Society*, 37:66-71
25. Nunez, de, Gonzalez, M.T., Boleman, R.M., Miller, R.K., Keeton, J.T. and Rhee, K.S.(2008).Antioxidant properties of dried plum ingredients in raw and precooked pork sausage. *Journal of food science*, 73: 63-H71
26. Nuñez, de, Gonzalez, M.T., Hafley, B.S., Boleman, R.M., Miller, R.K., Rhee, K.S., & Keeton, J.T. (2009). Qualitative effects of fresh and dried plum ingredients on vacuum packaged, sliced hams. *Meat Science*, 83: 74–81.
27. Mansouri, A., Embarek, G., Kokkalou, E., & Kefalas, P. (2005). Phenolic profile and antioxidant activity of the Algerian ripe date palm fruit (Phoenix dactylifera). *Food Chemistry*, 89: 411–420.
28. Saleh, F.A. and Otaibi, M.M., (2013). Antibacterial activity of date palm (Phoenix dactylifera L.) fruit at different ripening stages. *Journal of Food Processing and Technology*, 4(12).