Research article

# Effect of oggtt on physicochemical properties, antioxidant activity and volatile compounds of noodles

Wafaa K. Bahgaat, Gamil E. Ibrahim, Ahmed M. S. Hussein

[1] Department of Dairy Science, National Research Centre, Dokki, Egypt
[2] Chemistry of Flavour & Aroma Department, National Research Center, 12622, Dokki, Egypt.
[3] Food Technology Department, National Research Center, Dokki, Egypt.

gamilemad2000@gmail.com

**Abstract:** *The present investigation aimed to evaluate the effect of noodles supplementation with oggtt at (5,10,15 and 20%) on physicochemical properties, antioxidant activity as well as volatile compounds. The cooked noodles evaluation based on cooking quality like volume and cooking loss as well as colour changes. An increase in protein, fat and ash was observed with the increase of oggtt supplementation level in noodles. The whole wheat flour had the highest value of total phenolic (462.3 µg GAE $g^{-1}$) compared to oggtt and all fortified noodles without cooking and after cooking. The fortification levels of 5 and 10% did not affect significantly on colour and overall acceptability of noodles. The panelists scores recommended the usage levels of 5 and 10% of oggtt noodles which did not changed significantly in comparison with control sample. The evaluation of oggtt incorporation in noodles volatile compounds performed using HS-GC/MS analysis. Thirty volatile compounds in cooked noodles after fortification with oggtt had identified. The main volatile compound herein was 2-pentyl furan, which represent 44.12, 20.14 and 18.75% in cooked control and fortified noodles with oggtt at 5 and 10% respectively.*

***Keywords:*** *oggtt noodles; physicochemical properties; antioxidant; volatile compounds.*

## Introduction

Recently, there is an increase demand for development new healthier and functional food products that improve the human health [1-2]. Noodles in the second worldwide stable food after bread and can consider the most popular wheat-based food in Asia for several decades. In China about 40% of wheat used in production of various kinds of noodles [3-4]. All-over the world, with the change of life style there is quickly popularize of noodles due to several advantages such as rapid urbanization, characteristic flavor and taste, nutritional properties and easy preparation. Noodles are type of snacks had low content of protein and several essential micronutrients for children and adolescent women

[5-6]. The current interest in formulation and development of cereal products as noodles which had healthy properties like high protein content, low glycemic index to cause increase in starch intake and high dietary fiber [7-9]. Therefore, several trials had performed to improve the nutritional and functional characteristics of noodles by change the formulation or modification the processing conditions. The fortification of noodles by different additives such as banana flour, starch of tapioca or pea incorporation to enhance the quality of noodles were mentioned [10-13]. However, the fortification effect on noodles by fermented dairy products still remains unexplored.

The products produced from fermented milk like yoghurt, jameed or oggtt play a domestic role in health improvement due to availability use in human suffered from several diseases like lactose intolerance [14-17]. Among the traditional fermented milk in Saudi is oggtt which, manufacture by desert dwellers (Bedouins) from several milk types like bovine, sheep and camel or their mixture. The good acceptability of this fermented milk comes from its pleasant sensory characteristics, low fat, rich in minerals as calcium and high protein content [18-22].

Flavour is the most important factor in acceptability of food product by consumers, and there is an increase focus to study the properties of cereal products volatile and aroma characteristics [23]. Several studies carried out on flavor formation of rice noodles and indicated the role of enzymatic process and microbial fermentation in noodles flavor formation [24-25]. However, studies on the determination of volatile compounds in noodles fortified with fermented dairy products such as oggtt have been limited. Thus, the current study aimed to evaluate the effect of substitution of wheat flour by oggtt on noodles physicochemical properties, antioxidant activity and volatile compounds.

## Experimental

### Materials

Wheat flour (72% extraction rate) purchased from five stars Company, Swiss city, Egypt. The oggtt (made using camel milk) was purchased from a local market during 2019-2020 in Riyadh City in the Kingdom of Saudi Arabia, milled and placed into polyethylene bags for storage at 4°C until use and salt were purchased from local markets in Giza, Egypt. All chemicals were of analytical grade.

### Methods

#### *Preparation of oggtt noodle*

Wheat flour was well blended with oggtt powder to produce individual mixtures containing 5, 10, 15 and 20% oggtt. All samples were stored in airtight containers and kept at 5-7°C till use. Control prepared with no oggtt additive.

Noodles of oggtt was prepared as following; 100 g wheat flour and 1.25 g salt were mixed with a definite amount of water (46-48 mL) according to the method described [26]. The dough was shaped by using manual pasta maker of Titania brand (single unite steal pasta machine, Italy) and then cut into a Noodles sheets with 1.50 mm thickness, 70 mm width and 130 mm length averages. Noodles samples were dried at 45±5°C overnight in drying chamber (BLC-250-III, Beijing Land and Technology co., Ltd., Beijing, China), then packed in polyethylene bags and kept at room temperature for analysis.

***Cooking of noodles***

The noodle samples were cooked by placing a small amount (approximately 30 g) in a saucepan of gently boiling water (600 mL). The noodle was determined to be fully cooked if a uniform colour was obtained, indicating that the uncooked core had disappeared during about 5 minutes. It is noted that for this study, these noodles were prepared to have the same strand size in order to reduce the variability of cooking time.

***Cooking loss***

The determination of cooking loss carried out as mentioned by Rombouts [27]. The cooking water was collected and its volume adjusted to 500 mL with deionized water. An aliquot (50 mL) of the diluted cooking water was then transferred to a washed, dried and tarred beaker ($W_1$, in g) and dried in an air oven at 105°C for 15 h to constant weight ($W_2$, in g). The cooking loss was expressed as a percentage of the starting material and calculated as 40 X($W_2$ - $W_1$).

***Analytical techniques***

Moisture, ash, protein and fat contents of oggtt powder and prepared noodles were determined according to the methods outlined in [28], while carbohydrates were calculated by difference as mentioned by Tadrus [29].

***Rheological properties***

Rheological properties of doughs were evaluated using Farinograph according to [30].

***Cooking quality of Noodles***

Cooking quality of Noodle were carried out by measuring the increases in volume ($cm^3$) and cooking loss after cooking according the methods of [30].

***Color measurement***

The color of cooked and uncooked oggtt noodle samples was measured as described by Aydin and Duygu [31] by a hand-held Tristimulus reflectance colorimeter Minolta Chromameter (model CR-400, Konica Minolta, Japan). Results recorded in the L* a* and b*-values color system. The obtained values are presented as a means of triplicate determinations. The total color difference was determined according to the following equation:

$$\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$$

## Measurement of total phenolic content and antioxidant activity

### *Extract preparation*

Total phenolics were extracted from the samples by the method of [32]. Briefly, samples (about 2.0 g) were mixed with 16 mL of methanol containing 1% HCl for 24h at 30°C, the procedure was repeated twice. The methanol extracts were centrifuged at 4000 ×g for15 min and the resulting supernatants were pooled and stored at 4°C

### *Determination of total phenolic content (TPC)*

TPC was determined by the method of Singleton [33], extracts (0.5 mL) were mixed with 5 mL of Folin–Ciocalteu reagent (1 mol), neutralized with 4 mL saturated sodium carbonate (75 g $L^{-1}$), and kept at room temperature for 2 h. Absorbance at 765 nm was measured with a spectrophotometer. TPC was expressed as gallic acid equivalents (mg GAE $g^{-1}$)

### *DPPH radical scavenging activity assay*

The free radical scavenging activity of the noodles samples were measured using 1,1'- diphenyl-2-picryl-hydrazyl (DPPH) as mentioned by Almashad [34]. Briefly, 200 µL of each sample extract at various concentrations was added to 2 mL of DPPH solution (0.1 mM). The reaction mixture was shaken well and incubated in the dark for 15 min at room temperature. Methanol was used instead of the extract as a control. Then the absorbance was measured in triplicate at 517 nm. The capability to scavenge the DPPH radical was calculated using the following equation:

$$\text{DPPH scavenging effect (\%)} = [(A_0 - A_1/A_0) \times 100].$$

Where $A_0$ was the absorbance of the control reaction and $A_1$ equal the absorbance in the presence of the extract. The extract concentration providing 50% inhibition ($IC_{50}$) was calculated from the graph of DPPH scavenging effect against extract concentration (ug/g).

### *β–Carotene-linoleic acid assay*

β-Carotene bleaching assay was carried out according to the method developed by Ibrahim [35]. one milliliter of β-carotene solution (0.2 mg/mL chloroform) was pipetted into a round-bottom flask (50 mL) containing 0.02 mL of linoleic acid and 0.2 mL of 100% Tween 20. The mixture was then evaporated at 40°C for 10 min using a rotary evaporator (BUCHI, Germany) to remove chloroform. After evaporation, the mixture was immediately diluted with 100 mL of distilled water. The distilled water was added slowly to the mixture with vigorous agitation to form an emulsion. Five mL aliquots of the emulsion were transferred into different test tubes containing 0.2 mL of samples in 80% methanol at 1 mg/mL. The mixture was then gently mixed and placed in a water bath at 50 °C for 2 h. Absorbance of the sample extract after filtration was measured every 30 min for 2 h at 470 nm using UV-Vis Shimadzu Spectrophotometer (UV-1601 PC, Japan). Blank solution was prepared, containing the same concentration of sample without β- carotene. The total antioxidant activity was calculated based on the following equation:

$$AA = [1-(A_{S\,(0)}-A_{S\,(120)}/ A_{b\,(0)}-A_{b\,(120)})] \times 100$$

where: AA: Antioxidant activity; $A_{S(0)}$: is absorbance of sample at 0 min., $A_{S\,(120)}$: is absorbance of sample at 120 min., $A_{b\,(0)}$: is absorbance of blank at 0 min., $A_{b\,(120)}$: is absorbance of blank at 120 min. The extract concentration providing 50% inhibition ($IC_{50}$) was calculated from the graph of β-Carotene scavenging effect against extract concentration (ug/g).

Butylated hydroxyl anisol (BHA) was used as positive controls. All tests were run in triplicate and an average was used.

***Sensory evaluation***

All noodle samples (control, noodles fortified with 5, 10, 15, and 20% oggtt) were sensory evaluated in 1 session on 1 day. Panelists received the sample at a time with a 2 min break between samples. Each panelist individually evaluated the noodles in sequentially under incandescent light in laboratory. Noodles samples was organoleptically evaluated by ten panelists for its appearance, color, taste, tenderness and stickiness and overall acceptability using a 9-pointhedonic scale with 9-like extremely, 5-neither like nor dislike, 4-dislike slightly, and 1-dislike extremely [36]. The samples were blind labeled with random 2-digit codes, and the sample order was randomized.

***Volatile compounds analysis***

Volatile compounds of cooked noodles control and selected fortified samples with oggtt at 5 as well as 10% according to sensory evaluation data were isolated by headspace solid phase microextraction (HS-SPME) sampling and analyzed by gas chromatography coupled with mass spectrometry (GC/MS) as described by Boccacci-Mariani et [37]. About 10.5 grams of each samples were put into a 20-mL headspace vial, fitted with a Teflon-lined septum. Volatiles were sampled for 30 min at 50°C from the headspace of the vial using DVB/CAR/PDMS fiber (Divinylbenzene/Carboxene/Polydimethylsiloxane, Supelco, Bellefonte, Pa., U.S.A.). The fiber was then immediately inserted into the injection port of the gas chromatograph for 5 min at 260°C. The column DB-wax capillary column (60 m × 0.25 mm, 0.25 μm, RESTEK, USA) temperature was held at 40°C for 2 min and then increased at 10°C/min to 200°C, which was then held for 10 min. The mass spectra were determined at 70 eV, while the interface was held at 280°C. Identification of volatile compounds was achieved by comparing mass spectra with the Wiley library (Hewlett-Packard). The volatile compounds were also identified by matching the retention indices (RI) calculated according to [38] and based on a series of alkanes ($C_6$-$C_{22}$).

***Statistical analysis***

Statistical analysis was performed using SPSS software version 16.0 (SPSS, Chicago, Illinois). Comparison of means was conducted using one-way analysis of variance (ANOVA) with Post Hoc Tukey’s test at $P < 0.05$ [39].

## Results and Discussion

### Chemical composition of noodles supplemented with oggtt

The effect of oggtt incorporation in noodles formulation on chemical composition parameters are given in Table 1. There is a significant (*P*<0.05) difference in moisture content between control and fortification level at 20% oggtt when replacing by wheat flour. A similar trend was observed by Anderson [40] when they cooked sorghum grits by extrusion. The obtained results showed a significant (*P*<0.05) increase in protein, fat and ash in fortified noodles compared to control (no oggtt) sample (Table 1). The highest values of increase in aforementioned characteristics at 20% oggtt level, may be due to the increase concentration of these characteristics in oggtt. Our data in concord with [41] who studied the fortification biscuit with chicken meat.

**Table 1**. Proximate composition (%) of oggtt incorporated noodles

| Sample | Moisture | Protein | Fat | Ash | Carbohydrates |
|---|---|---|---|---|---|
| **Oggtt powder** | 11.89±0.33 | 27.97±1.71 | 5.84±0.12 | 2.12±0.04 | 64.07±1.79 |
| **Control** | 12.32±0.28[a] | 10.18±0.03 | 1.25±0.02[a] | 0.57±0.01[a] | 87.34±0.06[a] |
| **5 %oggtt** | 12.39±0.47 [a] | 11.17±0.03 [a] | 1.54±0.06[b] | 0.67±0.02[b] | 86.01±0.08[a] |
| **10 %oggtt** | 12.34±0.16 [a] | 12.12±0.04[b] | 1.75±0.03[c] | 0.76±0.02[c] | 84.79±0.06[b] |
| **15%oggtt** | 12.41±0.12[a] | 13.12±0.09 [b] | 2.03±0.08[d] | 0.83±0.03[d] | 83.44±0.17[b] |
| **20%oggtt** | 12.81±0.08 [b] | 14.02±0.07[c] | 2.21±0.05[e] | 0.90±0.02[e] | 82.35±0.10[c] |

Values are expressed as (Mean±SD); Different letters in the same column are significantly different

The obtained results exhibited that fortification of noodles with oggtt improved the protein content to be 14.02% at 20% level of oggtt in comparison with 5% level of oggtt which had 11.17% only and control sample (10.18%) as shown in (Table 1). In noodles manufacture, it is important to contain correct protein content for texture characteristics [42-43].

**Table 2**. Rheological properties of noodles dough fortified with oggtt using farinograph

| Sample | Water absorption (%) | Arrival time (min) | Dough stability (min) | (DDT) (min) | Dough weakening (B.U) |
|---|---|---|---|---|---|
| **Control** | 58.00 | 1.50 | 7.50 | 3.00 | 70 |
| **5% oggtt** | 59.00 | 1.50 | 8.00 | 2.50 | 60 |
| **10% oggtt** | 61.00 | 1.50 | 9.00 | 2.50 | 55 |
| **15% oggtt** | 63.00 | 1.50 | 10.50 | 2.00 | 43 |
| **20% oggtt** | 64.00 | 1.50 | 10.00 | 3.00 | 20 |

DDT: Dough Development time

The protein content required for Chinese noodles ranged from 8-13%. However, in China there is no standard limit for protein content for each kind of noodles [44-45]. The fortification process of noodles with oggtt make the level of protein in the standard range of protein content for noodles [46].

**Rheological properties of noodles dough fortified with oggtt**

Rheological study was carried out to select the best replacement level of oggtt with wheat flour to produce acceptable noodles. Therefore, the control sample as well as the noodles dough samples fortified with oggtt at four levels were subjected to farinograph analysis and the obtained results are given in Table (2).

Our data showed that the farinograph parameters such as water absorption and dough stability increased with increasing the added level of oggtt compared to control sample. The increase in water absorption in supplemented samples may be due to high content of oggtt from carbohydrates and protein. The protein content in oggtt reach to 30% as mentioned by Al-Abdulkarim [47] and could be ranged from 37.54% to 38.81 during storage as recorded [48]. On the other hand, total carbohydrates of oggtt recorded by Al-Ruqaie [49] to be in the range of 33.8% to 35.5% in various oggtt samples.

**Noodles colour quality**

The fortification of uncooked noodles with oggtt caused an increase in L-value from 72.68 in uncooked control sample to 77.94 in noodles fortified with 20% oggtt (Table 3). A similar trend was observed in a and b-values which indicate there is no green or blue colour formation had occurred after cooking in noodles samples. These results in contrast [31-50] who found a decrease in L-value and increase in a and b-values of noodles fortified with oat flour. So, they mentioned that oat flour had adversely effect on the sensory properties of noodles.

**Table 3.** Effect of cooking and oggtt fortification on colour evaluation of noodles

| Sample | Uncooked | | | | Cooked | | | |
|---|---|---|---|---|---|---|---|---|
| | L* | a* | b* | ΔE | L* | a* | b* | ΔE |
| **Control** | 72.68±0.63[a] | 3.06±0.03[a] | 17.71±0.28 | - | 66.27±0.08[a] | 1.69±0.31 | 16.46±0.66[d] | - |
| **5% oggtt** | 76.38±0.28[b] | 3.04±0.05[a] | 16.39±0.13[b] | 3.94±0.26[b] | 66.38±0.14[a] | 4.27±0.14 | 18.54±0.67[b] | 3.36±0.83 |
| **10% oggtt** | 77.24±0.99[c] | 3.24±0.12 | 17.29±0.18[a] | 4.60±0.45[a] | 62.09±0.49[b] | 6.21±0.24[a] | 20.21±0.35[a] | 7.24±0.12 |
| **15% oggtt** | 77.32±0.49[c] | 3.45±0.09[b] | 17.95±0.23[a] | 4.67±0.26[a] | 59.37±0.87[c] | 7.54±0.10[a] | 21.44±0.28[a] | 10.36±0.15 |
| **20% oggtt** | 77.94±0.23[c] | 3.42±0.08[b] | 18.17±0.16[c] | 5.30±0.43[c] | 58.40±1.65[c] | 8.48±0.29 | 23.14±0.17[c] | 12.39±1.56 |

Values are expressed as (Mean±SD); Different letters in the same column are significantly different

**Antioxidant activity**

The determination of total phenolic content was carried out by Foin-Ciocalteu method and the results are given in Table 4. The data showed that whole wheat flour without processing had the highest value of total phenolic (462.3 µg GAE/g) compared to oggtt and all fortified noodles after cooking. Our data are confirmed by [51-52].

**Table 4**. Effect of cooking on total phenolic content and free radical scavenging ($IC_{50}$) using DPPH and β–Carotene assays of noodles fortified with oggtt

| Sample | TPC µg GAE $g^{-1}$ | DPPH µg/g | β–Carotene-linoleic acid µg/g |
|---|---|---|---|
| **Wheat flour** | 462.3±0.31[a] | 0.93±0.16[a] | 0.95±0.12[a] |
| **Oggtt** | 237.4±0.19[f] | 3.28±0.28 | 2.89±0.34[b] |
| | **Before cooking** | | |
| **Control** | 423.6±0.23 | 1.95±0.45[b] | 2.13±0.14 |
| **5** | 435.7±0.18 | 1.47±0.26 | 1.89±0.21[c] |
| **10** | 445.9±0.39 | 1.16±0.18 | 1.72±0.18[c] |
| **15** | 461.7±0.41[a] | 0.96±0.13[a] | 1.25±0.19 |
| **20** | 468.3±0.25[d] | 0.82±0.24 | 0.96±0.12[a] |
| **BHA** | | 0.34±0.08 | 0.37±0.07 |
| | **After cooking** | | |
| **Control** | 352.8±0.31[b] | 2.85±0.61 | 3.12±0.18 |
| **5** | 359.7±0.15[b] | 2.76±0.52 | 2.98±0.23[b] |
| **10** | 369.2±0.42[c] | 2.42±0.19 | 2.76±0.57[d] |
| **15** | 374.2±0.16[c] | 2.38±0.16[b] | 2.54±0.64[d] |
| **20** | 381.6±0.34[e] | 2.31±0.27[b] | 2.38±0.92 |
| **BHA** | | 0.51±0.12 | 0.59±0.14 |

Values are expressed as (Mean ± SD); Different letters in the same column are significantly different

The processing treatments including, milling heating affect negatively on the total phenolic content as well as reduce antioxidant activity. Chlopicka et al. [53] found that total phenolic content of bread is about 2-4 folds less than of flour used in the processing. The analysis of antioxidant activity of wheat flour, oggtt, control noodles and samples fortified with oggtt was carried out using DPPH and β–Carotene-linoleic acid assays and the results are given in Table 4 as $IC_{50}$ in comparison with BHA.

All the fortification levels showed dos-dependent relationship with increasing antioxidant activity, the highest level of fortification (20% oggtt) was the most effective level with $IC_{50}$ values (0.82 and 0.96 µg/g) when determination was performed using DPPH and β–Carotene respectively for sample before cooking. However, all the treated samples were showed higher antioxidant activity compared to control sample but lower than BHA as a positive control (0.34 and 0.37 µg/g) after analysis with DPPH and β–Carotene methods respectively. The previous studies mentioned that the antioxidant activity caused by different types of polyphenolic compounds in plant and various phenolic molecular structure [54]. The reduction in antioxidant activity in cooked and formulated noodles may be due to the reduction in total phenolic content during processing and loosing of phenolic acids as well as flavonoids breaking down after cooking or during extraction [55-56]. These results in good agreement with Yu et al. [57] who found that the antioxidant of refined flour and bread are less than that of whole-wheat flour.

**Effect of oggtt on cooking properties of noodles**

The overall quality of oggtt noodles after cooking including volume increasing and cooking loss are given in Table 5. The supplementation of noodles with oggtt caused a significant increase in noodles volume and reach maximum losing value at 20% replacing of wheat flour with oggtt. However, the increase at 5% level of oggtt did not significantly ($P \leq 0.05$) differed compared to control sample (Table 5).

**Table 5**. Physical properties of cooked noodles

| Sample | Volume increasing | Cooking loss (%) |
|---|---|---|
| **Control** | 145±3.50[a] | 3.42±0.02[a] |
| **5% oggtt** | 150±4.00[a] | 3.45±0.03[a] |
| **10% oggtt** | 165±2.50[b] | 4.65±0.03[b] |
| **15% oggtt** | 170±3.50[b] | 4.73±0.03[b] |
| **20% oggtt** | 180±3.50[c] | 6.11±0.03[c] |
| **LSD at 0.05** | **7.154** | **0.042** |

Values are expressed as (Mean±SD); Different letters in the same column are significantly different

The results revealed that, increasing volume ($cm^3$) of oggtt noodles had occurred compare to control sample (no oggtt). The results showed that there is no significant difference in cooking loss between control noodles and fortification level of 5% oggtt as well as between the levels of 10 and 15%. However, all the samples are significantly difference compared to 20% oggtt level. The dramatic increase in cooking loss at high level of oggtt fortification may be due to alkalinity of this product and high concentration of salt which increase α- and γ-gliadins solubility [58]. Another interpretation for this high cooking loss mentioned by Rombouts et al. [27] due to gelatinization of starch with the same time of interplay among gluten network and salt.

**Sensory evaluation of oggtt incorporation in noodles**

The sensory attributes including, appearance, colour, taste, stickiness, tenderness as well as overall acceptability of noodles fortified with oggtt after cooking had investigated and the obtained results are given in Table 6.

**Table 6**. Sensory quality of oggtt incorporation noodles after cooking

| Sample | Appearance (9) | Colour (9) | Taste (9) | Stickiness (9) | Tenderness (9) | OAA (9) |
|---|---|---|---|---|---|---|
| **Control** | 9.30±0.35[a] | 9.83±0.38[a] | 9.63±0.22[a] | 9.11±0.37[a] | 8.95±0.33[a] | 9.58±0.47[a] |
| **5% oggtt** | 9.11±0.31[a] | 9.55±0.35[a] | 9.77±0.24[a] | 9.45±0.33[a] | 9.34±0.36[a] | 9.44±0.43[a] |
| **10% oggtt** | 8.92±0.30[a] | 9.50±0.29[a] | 9.56±0.23[a] | 9.52±0.31[b] | 9.21±0.44[a] | 9.12±0.41[a] |
| **15% oggtt** | 8.80±0.28[b] | 9.51±0.41[a] | 8.31±0.32[b] | 7.70±0.29[c] | 8.20±0.29[b] | 8.37±0.32[b] |
| **20% oggtt** | 8.43±0.30[b] | 9.79±0.47[a] | 7.66±0.16[c] | 7.30±0.30[c] | 7.68±0.27[c] | 7.80± 0.33[c] |
| **LSD at 0.05** | **0.442** | **0.509** | **0.386** | **0.411** | **0.526** | **0.538** |

OAA: Overall acceptability; Values are expressed as (Mean±SD); Different letters in the same column are significantly different

The recorded data exhibited that the best scores for control (no oggtt) followed by fortification at 5 and 10% oggtt level and a dramatic decrease in the studied properties scores occurred with increase the level of fortification especially in taste, stickiness and tenderness (Table 6). The evaluation of taste and tenderness were significantly ($P$<0.05) lower than control sample, but still moderately acceptable by panelists.

The increase level of oggtt fortification in noodles showed a reduction in appearance in the levels at 15 and 20%, but the lower level (5 and 10%) are not significantly differed from control sample. However, the scores of colour by panelists did not showed any significant changes compared to control (no oggtt). This result is confirmed with the previous colour parameter (L, a & b) of at all fortifications levels in Table (3). Also, the obtained colour result in agreement with [59], who mentioned that spaghetti control sample ranked higher score in colour compared to samples treated with bran. Among the most important quality parameter in noodles evaluation is stickiness. In the current study stickness did not differed significantly between control and fortified samples with oggtt at 5 and 10% revels where the scores for stickiness were 9.11, 9.45 and 9.52 in control, fortified levels at 5 and 10% respectively (Table 6). Generally, the panelists scores recommended the usage levels of 5 and 10% of oggtt noodles which did not changed significantly in comparison with control sample.

**Analysis of volatile compounds in noodles fortified with oggtt using GC/MS**

The analysis of volatile constituents in cooked control noodles as well as the fortified samples with oggtt at 5 and 10% levels carried out using GC-MS and the obtained data are given in (Table 7).

The results showed that a total of thirty volatile compounds in noodles after fortification with oggtt belong to various chemical classes had identified. The main identified volatile compound herein was 2-pentyl furan which represent 44.12, 20.14 and 18.75% in cooked control and fortified noodles with oggtt at 5 and 10% respectively. It is play a domestic role in flavor of noodles and pasta due to presence in flour, dough and stability after boiling of noodles [20]. In cooked noodles the furan and furans derivatives generation occurred in pathways of Maillard reaction from cysteine [60-61].

Among the most common aldehydes in the current study is hexanal with concentration of 8.64% in control noodles and showed a remarkable decrease in fortified noodles to be at 5.49 and 3.25% at 5 and 10% fortification levels respectively (Table 7). The formation of aldehydes and alcohols in cooked noodles linked to the concentration of linolenic and linoleic acids as reported by [62]. Therefore, there is relationship between noodles volatile formation and fatty acids oxidation as well as enzymes activity. The significant decrease in 2-pentylfuran and hexanal mainly clarify the low scores of panelists in sensory evaluation (Table 6). Wu et al. [63] reported a significant concentrations of aldehydes in fresh potato noodles compared to cooked noodles prepared from wheat. Suzuki et al. [64] mentioned that there is a strong relationship between aldehydes formation like hexanal and enzyme activity such as peroxidases and lipases. The low threshold values of aldehydes make it play a significant role in noodles flavor even at low concentrations [65-66]. The increase noodles fortification with oggtt made negative effect in flavor compounds under processing conditions of the present study. These data are in contrast to Ma et al. [67] who mentioned that the fortification process using buckwheat in noodles had an excellent scores in aroma and taste as well as mouthfeel and the small bitter taste due to the presence of rutin. Therefore, further studies are in need to identify non-volatile compounds, which may explain the rejection of panelists for taste in oggtt noodles.

**Table 7.** Volatile compounds in oggtt noodles, odour threshold and odour property

| Volatile compound | RI [a] | Control | 5% | 10% | OT (ng/g) [c] | Odour property [d] |
|---|---|---|---|---|---|---|
| 3-Methylbutanal | 915 | 0.06[b] | 2.16 | 3.07 | 0.2 | malty |
| Ethanol | 937 | 9.25 | 7.34 | 6.52 | 4510 | |
| Pentanal | 986 | 2.19 | 0.62 | 0.76 | | |
| Decane | 1007 | 3.32 | 4.87 | 5.13 | | |
| Hexanal | 1113 | 8.64 | 5.49 | 3.25 | 5 | green |
| 2-Butylfuran | 1154 | 0.26 | 1.04 | 4.26 | | |
| Dodecane | 1203 | 1.59 | 2.85 | 5.13 | | |
| Heptanal | 1207 | 0.05 | n.d | 0.19 | 3 | |
| 1-Penten-3-ol | 1216 | 0.26 | 0.17 | n.d | | green, fruity |
| 2-Pentylfuran | 1236 | 44.12 | 20.14 | 18.75 | | |
| (E)-2-Hexenal | 1246 | 0.10 | 3.46 | 4.12 | | |
| 2-Methyl-1-butanol | 1264 | 0.04 | 4.01 | 6.07 | | |
| 3-Methyl-1-butanol | 1268 | 0.16 | 5.12 | 4.53 | 300 | |
| Octanal | 1297 | 0.08 | 4.16 | 1.28 | 0.7 | |
| 2-Octanone | 1301 | 0.08 | 1.39 | 0.43 | | |
| 1-Pentanol | 1302 | 8.07 | 7.24 | 6.19 | 4000 | fruity |
| 3-Heptanol | 1329 | 0.01 | 3.16 | n.d | | |
| Nonanal | 1385 | 0.20 | n.d | 0.7 | 1 | fat, citrus, green-like |
| 1-Hexanol | 1387 | 0.17 | 3.47 | 0.89 | 2500 | flowery, fruit |
| 3-Octanol | 1412 | 0.28 | 3.12 | 2.58 | | fresh orange rose |
| (E)-2-Octenal | 1436 | 0.08 | 0.59 | 0.61 | | |
| 1-Octen-3-ol | 1462 | 6.12 | 2.43 | 0.92 | | musty-like |
| 1-Heptanol | 1476 | 0.20 | 1.37 | 0.54 | | mushroom |
| Decanal | 1489 | 0.09 | n.d | 1.62 | 2 | floral |
| 2-Ethyl-1-hexanol | 1502 | 2.73 | 0.09 | n.d | | |
| Benzaldehyde | 1531 | 0.09 | 0.28 | 3.18 | 350 | sweet, almond, nutty |
| 1-Octanol | 1563 | 0.01 | 1.69 | 2.46 | | orange-like |
| 1-Nonanol | 1664 | 4.97 | 1.58 | 1.29 | | |
| Hexanoic acid | 1852 | 0.08 | 9.14 | 8.42 | | |
| Benzyl alcohol | 1883 | 0.06 | 0.56 | 4.16 | | |

[a]: RI: retention index; [b]: Values as relative area percentage; OT: odour threshold cited from Keatkrai and Wannee [25]. n.d: not detected; [d]: Odour property cited from Narisawa et al. [23].

The most common alcohols in control sample were ethanol; 1-pentanol; 1-octen-3-ol and 1-nonanol which represent a concentrations of 9.25; 8.07; 6.12 and 4.97% respectively (Table 7). The identified alcohols in the current study did not play significant role in flavor characteristic of noodles due to their high threshold. Their important in overall noodles characteristic flavor could be interpreted with flavor interaction in mixture [67]. The aforementioned alcohols showed decrease values with increase of oggtt during preparation of noodles like ethanol which decrease from 9.25% in control sample to 7.34 and 6.52% at 5 and 10% fortified levels respectively. However, another alcohols such as 3-octanol showed a reversible trend when increase to 3.12% and 2.58% at the applied levels compared to 0.28% only in control sample (Table 7). Our results in accordance with Wu et al. [63] who found a remarkable increase in some alcohols in cooked noodles compared to fresh samples. The obtained results found that alcohols like identified in the current investigation with considerable concentration and these alcohols characterized with celery-like aroma and fruity flavor. The significant increase in some alcohols like 2-methyl-butanol and 3-methyl-butanol in fortified samples in comparison with control treatment are not significant in characteristic flavor of noodles and acceptability by panalists. These data are confirmed by Narisawa et al. [20] who mentioned that these alcohols formed during fermentation and are not significant in flavor of Japanese noodles.

Alkanes such as decane and dodecane were identified with significant concentrations in control sample (3.32, and 1.59% respectively (Table 7). The relative concentrations of these alkanes showed a significant increase in fortified noodles and characterized with soapy, grassy and fatty flavor as mentioned by Dong et al. [69]. The high concentrations of these products correlated with off-flavour and rancidity of cereal products [70]. Therefore, the negative scores of sensory evaluation in high fortifications may be correlated the high concentrations of these alkanes. To date, few studies carried out to shade the light on noodles volatile compounds change after fortification with fermented dairy products like oggtt. So, there is extend of the present study to identify the volatile compounds in prepared oggtt under Egyptian conditions as well as its effect on noodles volatile during storage.

## References

1. Al-Faris N, Al-Jobair M. Physico-chemical characteristics of pan and pita bread supplemented with the products of goat oggt. International Food Research J. **2017**; 24(5): 1889-1896.
2. Tiwari P, Rakesh K P. Estimation of Total Phenolics and Flavonoids and Antioxidant Potential of Ashwagandharishta Prepared by Traditional and Modern Methods. Asian J. Pharm. Ana. **2013**; 3(4): 147-152.
3. FAO. Food and Agriculture Organisation Agricultural Statistics Databases: Crop Production [Online]. Available from <http://www.fao.org>.**2005.**

4. Li M, Sun,Q. J, Han CW, Chen HH, Tang W. Comparative study of the quality characteristics of fresh noodles with regular salt and alkali and the underlying mechanisms. Food Chemistry, **2018**; 246: 335–342.
5. Verma AK, Pathak V, Singh VP. Quality Characteristics of Value Added Chicken Meat Noodles. J. Nutrition and Food Science, **2014**; 4: 255-259.
6. Sandey KK, Asgar S, Manorama PL. Utilization of Little Millet Flour for Preparation of Dairy Product. Research J. Science and Tech. **2009**; 1(2) 71–73.
7. Giannou V, Tzia C. Frozen dough bread: Quality and textural behavior during prolonged storage. Prediction of final product characteristics. J. Food Eng. **2007**; 79(3) 929–934.
8. Bustos MC, Perez GT, Leon AE. Sensory and nutritional attributes of fibre-enriched pasta. LWT – Food Sci. Technol. **2011**; 44:1429–34.
9. Priya R, Kawarkhe, S V, Deshmane, K, Biyani R. Formulation and Evaluation of Antioxidant Face Cream Containing Raspberry Fruit and Grape Seeds Extract. Research J. Topical and Cosmetic Sci. **2016**; 7(2) 73–78.
10. Chong LC, Noor A. Effects of banana flour and β-glucan on the nutritional and sensory evaluation of noodles. Food Chemistry. **2010**; 9(1)34–40.
11. Jiecheng L. Physicochemical and sensory properties of fresh noodles fortified with ground linseed (*Linum usitatissimum*). LWT - Food Sci. and Techn. **2019**; 101: 847–853.
12. Satomi E, Noritoshi K, Katsuyoshi N, Miki Y. Effects of esterified tapioca starch on the physical and thermal properties of Japanese white salted noodles prepared partly by residual heat. Food Hydrocolloids, **2014**: 35: 198–208.
13. Wang N, Maximiuk L, Toews R. Pea starch noodles: Effect of processing variables on characteristics and optimisation of twin-screw extrusion process. Food Chem. **2012**; 133: 742–753.
14. Madhu CJ, Swapna K, Neelima MV. Shah. A Comparative Evaluation of the Antioxidant Activity of Some Medicinal Plants Popularly Used in India. Asian J. Res. Pharm. Sci. **2012**; 2(3) 98–100.
15. Sathiyamoorthy R N. Phytochemical Screening and Antioxidant Studies in the Pulp Extracts of Cucurbita maxima. Asian J. Pharm. Res. **2016**; 6(1) 01–04.
16. Sandey KK, Asgar S, Manorama PL. Utilization of Little Millet Flour for Preparation of Dairy Product. Research J. Science and Tech. **2009**; 1(2) 71–73.
17. Vrese M, Steglmann A, Richter B, Fenselaws LC, Schrezenmeir J. Probiotics-Compensation for lactose insufficiency. American J. Chemical Nutrition. **2001**; 73: 4215–4295.
18. Jennifer Jothi Mary A. Human Milk Banks – An Increasing Importance. Int. J. Adv. Nur. Management. **2016**; 4(3): 299–300.
19. Sherin A. Hameed, Joyamma V P, Schiff bases and Bicyclic derivatives comprising 1, 3, 4-thiadiazole moiety- A Review on their Pharmacological activities. Asian J. Pharm. Res. **2019**; 9(4)299–306.
20. Hallabo SA, Magoli SB, Mohamed SK, Ramy A. Effect of processing on the chemical composition and amino acid pattern of supplemented macaroni. Bulletin of the Faculty of Agriculture, Cairo, University, **1985**; 36,171–186.
21. Mazahreh AS, Al-Shawabkeh AF, Quasem JM. Evaluation of the chemical and sensory attributes of solar and freeze-dried Jameed produced from cow and sheep milk with the addition of carrageenan mix to the Jameed paste. American J. Agric. and Biolo. Sci. **2008**; 3(3): 627–632.

22. Al-Abdulkarim BO, Maha S, Osman EM. Determination of chemical composition, and storage on dried fermented goat milk product (Oggtt). J. the Saudi Society of Agric. Sci. **2013**; 12, 161–166.
23. Narisawa T, Nakajima H, Umino M, Kojima T, Asakura T, et al. Volatile Compounds from Japanese Noodles, "Udon," and their Formation During Noodle-Making. J Food Process Technol. **2017**; 8(11) 1000700.
24. Lu ZH, Cao W, Peng HH, Wang F, Tatsumi E, Kohyama K, Li LT. Effect of fermentation metabolites on rheological and sensory properties of fermented rice noodles. J. the Science of Food and Agric. **2008**; 88(12) 2134–2141.
25. Keatkrai J, Wannee J. Volatile profile of khanom jeen, Thai fermented rice noodles, and the changes during the fermentation process. ScienceAsia. **2010**; 36: 46–51.
26. Bui L, Small D. The impact of flours and product storage on the thiamin content of Asian noodles. LWT – Food Science and Technology, **2008**; 41: 262–269.
27. Rombouts I, Koen JA, Jansens BL, Jan AD, Ke-Xue Z. The impact of salt and alkali on gluten polymerization and quality of fresh wheat noodles. J. Cereal Science. **2014**; 60: 507–513.
28. AOAC Association of Official Analytical Chemists. In Official Methods of Analyses, 17th. ed. Gaithersburg. M.D. **2000**.
29. Tadrus, MD. Chemical and biological studies on some baby food. M.Sc. thesis, Faculty of Agriculture, Cairo Univesity, Egypt. **1989**.
30. AACC. Approved Methods of the American Association of Cereal Chemists. 10th Edn., American Association of Cereal Chemists Press, St. Paul, MN., USA. 2000.
31. Aydin E, Duygu G. Cooking Quality and Sensorial Properties of Noodle Supplemented with Oat Flour. Food Sci. Biotechnol. **2011**; 20(2): 507-511.
32. Moore J, Liu JG, Zhou K, Yu L. Effects of genotype and environment on the antioxidant properties of hard winter wheat bran, J. Agric. Food Chem. **2006**; 50: 6182–6187.
33. Samal. P. K. Investigation of Antioxidant Activity of Hibiscus vitifolius leaves. Asian J. Res. Pharm. Sci. **2013**; 3(4) 215–219.
34. Almashad AA, Ibrahim GE, Rabab H. Phytochemicals, antioxidant and volatile compounds evaluation of Egyptian purslane leaves. Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, Egypt. **2019**; 27(5), 2573–2582.
35. Ibrahim G, Manal MH, Heba IA. Effect of Exo-polysaccharides from different Penicillium sp. On quality of cloudy apple juice during storage. Journal of Food Science Research. **2016**; 1(1) 015–026.
36. Inglett GE, Peterson SC, Carriere CJ, Maneepun S. Rheological, textural, and sensory properties of Asian noodles containing an oat cereal hydrocolloid. Food Chem. **2005**; 90: 1–8.
37. Boccacci-Mariani M, Giannetti V, Testani E. HS-SPME/GC-MS method to characterize the flavour of Italian pasta: potential application to assess the quality of the products. Food Analytical Methods. **2013**; 7:64–72.
38. Adams R. Identification of essential oil components by gas chromatography/mass spectrometry. 4th ed. Allured Publishing Corp., Carol Stream, IL, USA. **2007**.
39. Mc-Clave JT, Benson PG. Statistical for business and economics. Maxwell Macmillan International editions. Dellen Publishing Co. USA, **1991**; 272–295.
40. Anderson RA, Conway HF, Pfeifer VF, Griffin EL. Gelatinization of corn grits by roll and extrusion cooking. Cereal Science Today. **1969**; 14: 4–12.

41. Kumar R, Berwal NK. Production of Value Added Chicken Meat Mince Incorporated Cookies and Their Cost Economics – Benefit Ratio. Pacific Business Review International. **2013**;5(12):61–70.
42. Park CS, Hong BH, Baik BK. Relationship between protein characteristics and instant noodle making quality of wheat flour. Cereal Chem. **2004**;81 (2) 159–164.
43. Zhao LF, Seib PA. Alkaline-carbonate noodles from hard winter wheat flours varying in protein, swelling power, and polyphenol oxidase activity. Cereal Chemi. **2005**; 82, 504–516.
44. Fu BX. Asian noodles: history, classification, raw materials, and processing. Food Res. Inter., **2008**; 41, 888–902.
45. Huang S, Quail K, Moss R, Best J. Objective methods for the quality assessment of northern-style Chinese steamed bread. J. Cereal Science. **1995**; 21, 49–55.
46. SB/T10139-93. Wheat flour used for Chinese noodle.
47. Al-bdulkarim B, Shaista A, Maha S. Effect of Packaging Materials on the Physico-Chemical, Microbiological and Sensory Quality of Cooked Oggtt. World Applied Sci. J. **2012;** 17 (8) 951–957.
48. Al-Hindi RR, Abd-ElGhani S, Assem F. Physicochemical Composition and Microbiological Quality of Oggtt: Saudi Arabian Traditional Dried Fermented Milk. American J. Food Technology. **2015**; 10 (5) 195–205.
49. Al-Ruqaie IM, EL-Nakhal HM, Wahdan AN. Improvement in the quality of the dried fermented milk product Oggtt. Journal of Dairy Research. 1987; 54, 429–435.
50. Reungmaneepaitoon S, Sikkhamondhol C, Tiangpook C. Nutritive improvement of instant fried noodles with oat bran. Songklanakarin J. Sci. Technol. **2006**; 28: 89–97.
51. Gokilavani S, Vijayabharathi V, Parthasarathy R. Physico-Chemical Characteristics and Antibacterial Activity of Chitosan Extracted from Shell of Crab Paratelphusa hydrodromous. Asian J. Res. Pharm. Sci. **2014**; 4(3) 125–128.
52. Naidu, N. Sudheer G. Kumar, K. Sivakrishna, K. Anjinaik, L. Praveen K, Sneha G. Anti microbial and antioxidant evolution of aqueous extract of Terminalia chebula using disc diffusion, $H_2O_2$ scavenging methods. Asian J. Res. Pharm. Sci. **2017**; 7(2)112–114.
53. Chlopicka J, Pasko P, Gorinstein S, Jedryas A, Zagrodzki P.Total phenolic and total flavonoid content, antioxidant activity and sensory evaluation of pseudocereal breads, LWT-Food Sci. Technol. **2012**; 46 548–555.
54. Prabakaran M V, Thennarasu PA. Screening of Antioxidant, Antimutagenic, Antimicrobial Activities and Phytochemical Studies on Sphaeranthus amaranthoides (Burm). Asian J. Pharm. Tech. **2011**; 1(4)125–129.
55. Zhang M, Chen H, Li J, Peng Y, Liang Y. Antioxidant properties of tartary buckwheat extracts as affected by different thermal processing methods, LWT-Food Sci. Technol. **2010**; 43: 181–185.
56. Lia Y, Maa D, Dexiang S, Chenyang W, Jian Z, Yingxin X, Tiancai G. Total phenolic, flavonoid content, and antioxidant activity of flour, noodles, and steamed bread made from different colored wheat grains by three milling methods. The Crop journal. **2015**;13: 328–334.
57. Yu LL, Nanguet AL, Beta T. Comparison of antioxidant properties of refined and whole-wheat flour and bread, Andioxidants. **2013**; 2: 370–383.
58. Ukai T, Matsumura Y, Urade R. Disaggregation and reaggregation of gluten proteins by sodium chloride. J. Agric. Food Chem. **2008**; 56 (3) 1122–1130.

59. Kordonowy R K, Young VL. Utilization of durum bran and its effect of spaghetti. Cereal Chem. **1985**; 62, 301–304.
60. Sucan M, Weerasinghe D. Process and reaction flavors: An overview. In M. Sucan & D. Weerasinghe (Eds.), Process and reaction flavors. Recent developments. Washington: American Chemical Society. **2005**.
61. van-Boekel, M. Formation of flavour compounds in the Maillard reaction. Biotechnology Advances, **2006**; 24, 230–233.
62. Sirisantimethakom L, Laopaiboon L, Danvirutai P, Laopaiboon P. Volatile compounds of a traditional Thai rice wine. Biotechnology. **2008** (7) 5:05–13.
63. Wu Y, Shan L, Yanyan Z, Min Z, Volatile Compounds of Different Fresh Wet Noodle Cultivars Evaluated by Headspace Solid-Phase Microextraction-Gas Chromatography-Mass Spectrometry. An Acad Bras Cienc. **2020**; 92(3) e20190063 DOI 10.1590/0001-3765202020190063.
64. Suzuki T, Kim SJ, Mukasa Y, Morishita T, Noda T, Takigawa S, Hashimoto N, Yamauchi H, Matsuura-Endo, C. Effects of lipase, lipoxygenase, peroxidase and free fatty acids on volatile compound found in boiled buckwheat noodles. J. Sci. Food Agric. **2010**; 90:1232–1237.
65. Iizuka-Furukawa S, Isogai A, Kusaka K, Fujii T, Wakai Y. Identification of 4-mercapto-4-methylpentan-2-one as the characteristic aroma of sake made from low-glutelin rice. J. Bioscience and Bioeng. **2017**; 123(2) 209–215.
66. Starowicz M, Georgios K, Henryk Z. Sensory analysis and aroma compounds of buckwheat containing products—a review. Critical reviews in food science and nutrition., **2018**; 58(11) 1767–1779.
67. Ma YJ, Guo XD, Liu H, Xu BN, Wang M. Cooking, textural, sensorial, and antioxidant properties of common and tartary buckwheat noodles. Food Sci. Biotech. **2013**; 22:153–159.
68. Grosch W. Evaluation of the key odorants of foods by dilution experiments, aroma models and omission. Chem Senses. **2001**; 26, 533–45.
69. Dong X, Hu X, Sun L, Zhang H, Wu L, Wang B. Volatile Compounds of Wheat Flour and Steamed Bread as Affected by Wheat Storage Time. SM Anal Bioanal Technique. **2018**; 3(1):1015.
70. Bryant RJ, Mc-Clung AM. Volatile profiles of aromatic and non-aromatic rice cultivars using SPME/GC-MS. Food Chem. **2011**;124: 501–513.