Utilization of Orange, Banana and Potato Peels in Formulating Functional Cupcakes and Crackers

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ABSTRACT

The present study aimed to utilize orange peels (OP), banana peels (BP) and potato peels (PP) in preparing functional cupcake and crackers. Seven minerals have been determined, the Na, K and Ca had higher values than Mg, Cu, Mn and Fe for all peels under study. The OP had the highest crude fiber content (12.0%), followed by BP (10.5%), whereas, PP exhibited the lowest content (5.0%). The OP had the lowest neutral detergent fiber (NDF) content (19.13%) and acid detergent fiber (ADF) content (12.6%), whereas BP possessed the highest NDF and ADF contents (47.42% and 39.55%, respectively). The NDF content of PP was 45.14% being closed to its counterpart in BP, while ADF content of PP (18.7%) was higher than ADF content of OP. Furthermore, the hemicellulose content was 6.53% in OP and 7.87% in BP, while it was 26.49% for PP. Data of sensory evaluation revealed significant improvement of cakes supplemented with different levels of OP up to 20%, whereas, cakes supplemented with BP and PP at the same levels were significantly less acceptable than the control cake. Elevating the supplementation levels of the aforementioned peels resulted in increasing the specific volume of cake and crackers as compared to their corresponding controls..

Key words: Orange peels, banana peels, potato peels, minerals, dietary fiber, cupcake, crackers, sensory properties.

INTRODUCTION

Food wastes have been considered neither a cost nor a benefit, and thereby have been used as animal feed or brought to landfills or sent for composting. This attitude has recently changed for several reasons including the growing environmental concerns; the demand for controls to minimize the impact of waste on human health, which is bringing about more stringent regulations, the high disposal costs that are eroding the already low profits of the food industry and the growing awareness of the benefits deriving from potentially marketable components present in food wastes (Laufenberg, *et al.*, 2003). In UK, food waste in manufacturing amounts of 3.9 million tones, and valued at 5.9 US $ billion/year. The Waste Resources Action Program (WRAP) estimates the value of global consumer food waste at more than 400 US $ billion/year (Parry *et al.*, 2015).

Food wastes are produced throughout all the food life cycle (excluding the agricultural food losses), up to 42% is produced by households, 38% occurs during food processing and 20% is distributed along the whole chain. This valorization can be achieved through the extraction of high value components such as antioxidants, proteins, polysaccharides, fibres, flavour compounds and phytochemicals, which can be reused as nutritionally and pharmacologically functional ingredients (Baiano, 2014).

Nowadays, dietary fiber and the other bioactive compounds are widely used as functional ingredients in processed foods. The market in this field is competitive and the development of new types of quality ingredients is a challenge for the food field. In this regard, it is interesting to consider not only the nutritional quality of the ingredient, but also its distribution, cost and other additional benefits, since the use of these ingredients would give added value to the production of these materials (Elleuch *et al.*, 2011).

Fruits, vegetables and their wastes contain many bioactive components such as dietary fiber and antioxidants. For instance, phenolics, thiol, and carotenoids, may protect from chronic disease, whereas dietary fiber prevention of degenerative diseases. As reviewed previously, numerous antioxidants could be extracted from food wastes as residual sources (Moure *et al.*, 2001). Antioxidant from fruits, vegetables and beverages play an important role in human health, for example preventing cancer and cardiovascular diseases, and lowering the incidence of different diseases (Oroian & Escriche, 2015).

Dietary fiber provides many health benefits. A generous intake of dietary fiber reduces the risk for developing the following disease: coronary heart disease, stroke, hypertension, diabetes, obesity, and certain gastrointestinal disorders. Furthermore, increasing consumption of dietary fiber improves serum lipid concentrations, lowers blood pressure, improves blood glucose in diabetes, promotes regularity, aids in weight loss, and appears to improve immune function (Anderson *et al.*, 2009, Abou-Bakr *et al.*, 2014).

The present study aimed to utilize each of orange, banana and potato peels for preparing functional cupcakes and crackers with high fiber content. The organoleptic properties of the products were also performed.

MATERIALS AND METHODS

Materials

About 15 kg each of fresh orange, banana and potato peels were collected from the local food and beverage stores, Alexandria markets, Alexandria Egypt. The other materials including wheat flour (72% extraction ratio), sugar, shortening, milk powder, baking powder, salt, dried active bakers' yeast, vanilla and refined corn oil (free from antioxidant-packed under inert gas conditions) were all purchased from Alexandria markets, Egypt.

Methods

Samples preparation

The fresh orange, banana and potato peels were collected individually, washed with tap water, followed with distilled water. All the aforementioned materials were sun dried for three days, grounded using laboratory grinder (Moulinex- AR1044), sieved through 60 mesh sieve, and finally packed in polyethylene bags and stored in a deep freezer at –18°C until analysis.

Analytical methods

Crude and dietary fibers (neutral detergent fiber "NDF" and acid detergent fiber "ADF") contents were determined according to the AOAC method NO. 962.09 (2000) *via* filter bags technology (Fiber analyzer, Ankon 200) USA model No: A220.

Minerals (Ca, Mg, Mn, Fe and Cu) were determined in ash solution using Atomic Absorption Spectrometer (AAS) (300VA-50-60 Hz-100-240V) UK. whereas Na and K were determined using Flame Photometer Model PEP7 as described by the AOAC (2000).

Technological methods:

Cake and cracker preparation

Cake and cracker products were prepared from blends containing 0, 10, 15, and 20% of orange, banana and potato peels powder. The cake formula included 120g wheat flour (72% extraction), 100g sugar, 100g whole egg, 14g milk powder, 25g shortening, 0.5g baking powder, 1.0g vanillin and 2.3g salt. Creaming method was used to mix the ingredients while blending was continued. Eggs were beaten into the creamed mixture, flour was poured into mini round cake panel pan 6 wells and baked at 180°C for 30 min, then the temperature was lowered to 160°C and continued for 30 min. Cakes were cooled to room temperature and packed in polyethylene bags (Bennion & Bamford, 1973, Singh *et al*., 2006). The cracker formula included 100g wheat flour (72% extraction), 2g sugar, 5g whole egg, 2g salt, 2g dried active bakers' yeast and 60 ml water. Ingredients were mixed into cohesive dough, rolled into a consistent, thin sheet was formulated using a pasta roller and cut in pieces after proofing. The crackers were baked at 210°C for 15 min. then cooled at ambient temperature (Ahmed & Abozed, 2015). The OP, BP and PP were added to the cakes and crackers at levels of 10, 15, 20% based on the weight of wheat flour.

Specific volume

The weight (g) of cakes and crackers were determined individually. The volumes (cm^3) of samples were determined by solid displacement method. Specific volume was calculated according to the method of the AACC (2000) as volume (cm^3)/weight (g).

Sensory evaluations

Cake and cracker samples were subjected to sensory evaluation test along with the control. Ten trained panelists were asked to evaluate the samples according to the method described by Hooda & Jood (2005) on hedonic scale consisting of 9 points ranged from 1 (extremely dislike) to 9 (extremely like). Crust colour, texture, taste, odour and overall acceptability of cake samples and colour, texture, taste, odour and overall acceptability of cracker samples, were subjectively evaluated.

Statistical analysis

The determinations were carried out in triplicate and data were reported as mean values ± standard deviation (SD). Data were statistically analyzed and the treatments were subjected to analysis of variance (one way Anova) followed by Duncan's multiple comparison test, at the 5% level of probability (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Fiber content of orange, banana and potato peels

The crude fiber content of orange peel (OP), banana peel (BP) and potato peel (PP) as well as the neutral detergent fiber (NDF), the acid detergent fiber (ADF), hemicellulose contents are given in Table (1). Orange peel had the highest crude fiber content (12.0%) followed by BP (10.5%) whereas, PP exhibited the lowest crude fiber content (5.0%) in which it possessed only 31.3% of OP crude fiber. In contrast, OP had the lowest contents of NDF (19.13%) and ADF (12.6%), which is in agreement with Ververis *et al.* (2007) who found that ADF of OP was 15.7%, while BP possessed the highest content of NDF (47.42%) and ADF (39.55%). These results are in agreement with Emaga *et al.* (2012) who reported that, NDF and ADF for BP depends on ripeness stage and ranged from 22.5% to 30.7% for ADF, while it ranged from 27.8% to 31.3% for NDF. Also, Table (1) shows that the NDF content of PP was 45.19 which was relatively closed to its counterpart in BP, and the ADF content of PP (18.7%) was higher than the ADF content of OP (12.6%). These data are not in agreement with Dhingra *et al.* (2012) who reported that total dietary fiber content for PP was 76.40% on dry weight basis (DW).

Moreover, Table (1) shows that the hemicellulose content (HC) was 6.53% in OP, this result is in agreement with that reported by Ververis *et al.* (2007) who found that the HC of OP was 6.1%. The HC of BP was 7.87% being closed to OP content and this value was slightly higher than that obtained by Ververis *et al.* (2007) for BP (5.30%), depending on the ripeness stage. On the other hand, the HC for PP (26.49%) was higher than both for OP (6.53%) and BP (7.875%).

Table 1: Fiber composition and mineral contents of orange, banana and potato peels on dry weight basis

Component	Orange peel	Banana peel	Potato peel
Fiber (%)			
Crude fiber	12.00	10.50	5.00
NDF	19.13	47.42	45.19
ADF	12.60	39.55	18.70
Hemicellulose*	6.53	7.87	26.49
Mineral (mg/ 100g)			
Sodium (Na)	42.81	106.25	59.92
Potassium (K)	46.66	89.63	88.25
Calcium (Ca)	176.10	30.21	161.21
Magnesium (Mg)	8.08	7.97	9.12
Iron (Fe)	3.37	16.91	1.19
Manganese (Mn)	1.16	0.86	0.71
Copper (Cu)	0.66	0.89	1.09

NDF: Neutral detergent fiber
ADF: Acid detergent fiber
* Calculated by difference (NDF – ADF)

Mineral content of peels

Mineral contents of OP, BP and PP as mg/ 100g dry sample are given in Table (1). It was obvious that Ca, K and Na possessed the higher values compared to the other four elements (Mg, Fe, Mn and Cu) in all the aforementioned peels. Barros *et al.* (2012) reported that Ca content of peels from two different varieties of orange ranged from 145.9 mg/ 100g to 165.4 mg/ 100g, being closed to the given results (176.1 mg/ 100g).

Banana peel was found to be rich in Na and K contents (106.25 and 89.63 mg/ 100g, respectively) compared with OP (42.8 and 46.6mg/ 100g, respectively), while, PP had K content (88.25 mg/ 100g) being very closed to BP (Table 1). Anhwange (2008) reported that K content of BP was 78.10 mg/ 100g, being slightly different from the present results (89.63 mg/ 100g).

The BP exhibited the highest content of Fe (16.91 mg/ 100g) as shown in Table (1) which was slightly higher than that reported by Nagarajaiah & Prakash (2011), who found that Fe content of BP was 10.00 mg/ 100g. On the other hand, Barros *et al.* (2012) reported that the Fe content of OP ranged from 0.731 to 1.009 mg/ 100g which was very different from the tabulated results (3.37 mg/ 100g).

All the aforementioned peels had almost similar concentrations of Mg, where PP exhibited the highest concentration (9.12 mg/ 100g), while BP and OP had very closed Mg contents (7.97 and 8.08 mg/ 100g, respectively) as shown in Table (1), Barros *et al.* (2012) reported that OP had Mg content ranged from 23.8 to 27.8 mg/ 100g, being higher than the present results (8.08 mg/ 100g).

The contents of Cu and Mn exhibited the lowest concentration compared to the other five minerals (Ca, Na, K, Mg and Fe) among all peels (Table 1). Barros *et al.* (2012) reported that Cu and Mn contents in OP ranged from 0.059 to 0.088 and from 0.212 to 0.339 mg/ 100g, respectively, which were lower than the tabulated results for OP (0.66 and 1.16 mg/ 100g, respectively).

Sensory evaluation of the cupcakes supplemented with OP, BP and PP

The sensory evaluation characteristics of the cakes supplemented with OP, BP and PP were evaluated by ten panelists. The crust colour, texture, taste, odour and overall acceptability were evaluated for the control sample along with other different supplemented cakes (Table 2).

Table 2: Sensory evaluation of cakes supplemented with different levels of orange, banana and potato peels

Treatment	Property				
	Crust colour	Texture	Taste	Odour	Overall acceptability
Control cake	7.6^{b}	8.2^{a}	6.8^{b}	5.2^{c}	6.5^{c}
Orange Peel					
10	8.7^{a}	7.9^{a}	8.7^{a}	6.9^{b}	8.2^{a}
15	8.3^{a}	7.1^{b}	8.1^{a}	7.7^{a}	7.9^{ab}
20	7.9^{ab}	6.4^{b}	7.4^{b}	8.2^{a}	6.9^{ab}
Banana Peel					
10	4.5^{c}	5.1^{b}	5.7^{b}	5.9^{bc}	5.2^{bc}
15	3.2^{d}	3.9^{c}	5.5^{b}	6.5^{b}	4.6^{c}
20	2.4^{d}	3.4^{c}	5.2^{b}	7.4^{a}	2.4^{d}
Potato Peel					
10	5.8^{c}	6.4^{b}	4.7^{c}	5.5^{c}	4.9^{c}
15	5.3^{c}	4.3^{c}	2.8^{d}	5.1^{c}	3.8^{a}
20	4.6^{c}	3.9^{c}	3.2^{d}	4.5^{d}	2.7^{d}

Mean values with the same subscript within the same column of each peel are not significantly different ($P \leq 0.05$)

Data of sensory evaluation test obviously revealed significant improvement of the overall acceptability of cakes supplemented with 10, 15 and 20% of OP being superior to the control. However, the control along with cake supplemented with 10% OP were comparable and superior in their texture compared to the other cakes with different OP supplementation levels (Table 2). These data are in accordance with the results reported by Sharoba *et al.* (2013). Data given in Table (2) shows that the cake supplemented with 10% OP, judged by panelists was significantly the most acceptable cake in terms of crust colour, taste, odour as well as for overall acceptability. None of the sensory properties of supplemented cakes with BP were significantly ranked as neither comparable nor better than their counterparts for the control cake. However, the cake supplemented with 20% BP was significantly the most acceptable in terms of odour as compared to other treatments along with the control (Table 2).

Cakes supplemented with PP at the three different levels were found to be significantly less acceptable than the control (Table 2). The only exceptions were scores given by panelists to odour of supplemented cakes with PP at 10% and 15% levels, since these scores were not significantly different from that given for the control. In accordance, Khalifa *et al.* (2015) found that substitution levels of 5% and 10% with PP produced acceptable cupcakes which did not significantly differ from wheat flour cupcakes.

Sensory evaluation of crackers supplemented with OP, BP and PP

The sensory evaluation of crackers supplemented with OP, BP and PP are listed in Table (3). Crackers were supplemented with OP, BP and PP at three different levels (10, 15 and 20%) and were subjected to sensory evaluation along with the control.

It was obvious that crackers supplemented with 10% OP were significantly the most acceptable in terms of (colour, taste and overall acceptability) as compared with the control and the other two supplemented crackers. Colour, crispiness and taste for crackers supplemented with 10 and 15% OP were significantly superior to the control. Furthermore, crispiness and odour for crackers supplemented with 20% OP were significantly superior as compared to other supplemented crackers along with the control (Table 3).

Table 3: Sensory evaluation of crackers supplemented with different levels of orange, banana and potato peels

Treatment	Property				
	Crust colour	Texture	Taste	Odour	Overall acceptability
Control cracker	5.9^{bc}	5.3^{c}	5.6^{b}	6.1^{c}	5.9^{b}
Orange Peel					
10	7.8^{a}	6.8^{ab}	6.8^{a}	7.3^{ab}	7.4^{a}
15	7.3^{ab}	6.6^{ab}	6.4^{a}	7.7^{a}	5.8^{b}
20	6.6^{b}	7.4^{a}	5.0^{b}	8.2^{a}	5.1^{c}
Banana Peel					
10	5.7^{bc}	6.0^{bc}	6.2^{a}	6.8^{bc}	6.9^{a}
15	4.9^{cd}	6.3^{ab}	5.5^{ab}	7.2^{ab}	6.1^{ab}
20	3.7^{d}	6.9^{ab}	4.1^{c}	7.5^{ab}	5.1^{c}
Potato Peel					
10	5.3^{b}	6.1^{bc}	5.8^{ab}	4.9^{d}	5.7^{b}
15	5.5^{b}	6.5^{ab}	6.5^{a}	5.3^{d}	6.3^{ab}
20	4.7^{c}	7.2^{a}	5.1^{b}	5.1^{d}	5.2^{c}

Mean values with the same subscript within the same column of each peel are not significantly different ($P \leq 0.05$)

It was clear that crackers supplemented with 10, 15 and 20% BP exhibited significantly better crispiness and odour as compared to the control. On the other hand, no differences could be traced in terms of colour and taste of crackers supplemented with 10 and 15 % BP as compared with the control (Table 3).

Crackers supplemented with 15% PP possessed significantly better crispiness, taste and over all acceptability as compared to the control. Although, for colour, supplemented cracker with PP at levels of 10 and 15% were significantly ranked as the control. Crackers supplemented with 20% PP had significantly the most acceptable crispiness as compared with the control and the other supplemented crackers (Table 3).

In the light of the data presented here, also, as mentioned earlier OP, BP and PP are considered as promising sources for natural antioxidants as well as dietary fibers and thereby can be utilized in preparing functional crackers that contain high fiber content. According to Alshikh *et al.* (2015), the antioxidant activities and the inhibition of cupric ion induced human low density lipoprotein (LDL) peroxidation and peroxiy radicals induced super coiled plasmide DNA strand scission are some functions of antioxidants. Consequently, antioxidants inhibit LDL and DNA damage.

Specific volume of supplemented cupcakes with OP, BP and PP

It is worth to mention that the specific volume of baked cake indicates the amount of air that can remain in the final product. A higher gas retention and higher expansion of the product leads to a higher specific volume (Chaiya & Pongaswatmanit, 2011).

The specific volume of the supplemented cakes and the control has been measured and listed in Table (4). It was clear that increasing the supplementation level (10, 15 and 20%) with orange, banana and potato peels resulted in increasing the supplemented cake specific volume's as compared with the control, this is in agreement with the results reported by Saeed (2010). The specific volume was 2.47 cm^3/g for BP at levels 10% supplementation level and increased to 3.06 cm^3/g with increasing supplementation level of OP to 20%. The specific volume of supplemented cake with orange waste at 5, 10, 15 and 20% were 2.578, 2.745, 2.931 and 3.212 cm^3/g, respectively, as mentioned by Sharoba *et al.* (2013).

On the other hand, specific volume of the supplemented cake with PP in the present study was comparable to that reported by Sharoba *et*

Table 4: Specific volume of the cupcakes supplemented with different levels of OP, BP, PP

Treatment	Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
Control	319.50	770	2.41
Orange peel			
10	334.63	860	2.57
15	284.17	790	2.78
20	254.09	750	3.06
Banana peel			
10	340.08	840	2.47
15	309.16	810	2.62
20	271.37	730	2.69
Potato peel			
10	330.67	830	2.51
15	306.81	810	2.64
20	290.14	790	2.72

OP: Orange peel BP: Banana peel
PP: Potato peel

al. (2013) who found that the cake supplemented with PP at different levels (5, 10, 15 and 20%) had specific volume of 2.397, 2545, 2.591 and 2.741 cm^3/g, respectively.

Specific volume of supplemented crackers with OP, BP and PP

The specific volume of the supplemented crackers and the control are presented in Table (5). The specific volume ranged from 1.51 cm^3/g for the control to 1.82 cm^3/g for the cracker supplemented with 20% OP. Data explored the same trend regarding the volume of supplemented cracker with banana and potato peels. In other words, supplemented cracker with 10% PP exhibited specific volume of 1.62 cm^3/g which increased to 1.78 cm^3/g with increasing supplementation level to 20%.

Table 5: Specific volume of the control cracker and the crackers supplemented with different levels of OP, BP, PP

Treatment	Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
Control	15.23	23	1.51
Orange peel			
10	12.96	21	1.62
15	13.01	22	1.69
20	9.89	18	1.82
Banana peel			
10	10.49	17	1.62
15	11.30	19	1.68
20	9.19	16	1.74
Potato peel			
10	12.34	20	1.62
15	9.88	17	1.72
20	10.11	18	1.78

OP: Orange peel BP: Banana peel
PP: Potato peel

The point of interest is that supplementation of crackers with OP, BP and PP resulted in elevating the specific volume of crackers. Consequently, incorporation of these peels in crackers leads to increase the amounts of air that can remain in the final product, which in turn improves the texture of the products.

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الاستفادة من قشور البرتقال والموز والبطاطس في تشكيل كيك قوالب وبسكويت جاف هش كأغذية وظيفية

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أجريت هذه الدراسة بهدف الاستفادة من قشور البرتقال، الموز، البطاطس كمخلفات غذائية في إعداد أغذية وظيفية ذات محتوى عال من الألياف الغذائية مثل الكيك والبسكويت الجاف الهش. كانت قشور البرتقال هي الأعلى في محتواها من الألياف الخام (١٢,٠٠٪) يليها قشور الموز (١٠,٧٠٪) في حين سجلت قشور البطاطس أدنى محتوى من الألياف الغذائية غير الذائبة في المنظفات المتعادلة NDF (١٩,١٣٪)، وتلك غير الذائبة في المنظفات الحامضية ADF (١٢,١٦٪)، في حين كانت قشور الموز هي الأعلى في محتواها من الـ NDF (٤٧,٤٢٪) والـ ADF (٣٩,٥٥٪)، وكان محتوى قشور البطاطس من الـ NDF ٤٥,١٩٪ وهو يقارب نسبياً نظيره في قشور الموز، وكان محتوى الـ ADF (١٨,٧٪) أعلى في قشور الموز عن قشور البرتقال. وتبين أن محتوى الهيميسليلوز في كل من قشور البرتقال والموز والبطاطس كانت ٦,٥٣٪، ٧,٨٧٪، ٢٦,٤٩٪ على الترتيب. كما تبين من تقدير سبعة عناصر معدنية في القشور موضع الدراسة أن محتواها من الكالسيوم، البوتاسيوم، الصوديوم، أعلى من محتواها من الماغنسيوم، النحاس، المنجنيز، الحديد.

أوضحت نتائج التقويم الحسي تحسناً كبيراً في التقبل العام للكيك المحتوي على قشور البرتقال بنسبة ١٠٪، ١٥٪، ٢٠٪ وكانت معاملة الكيك المحتوية على ١٠٪ من قشور البرتقال هي الأفضل معنوياً والأقرب إلى العينة الضابطة (الكنترول). من ناحية أخرى فلم تؤد إضافة قشور الموز إلى أي تحسن واضح في الخواص الحسية للكيك عند نسب الإضافة الثلاث (١٠٪، ١٥٪، ٢٠٪) مقارنة بالعينة الضابطة، وكان الكيك المحتوي على قشور البطاطس بنفس النسب هو الأقل معنوياً من حيث التقبل بالمقارنة بالعينة الضابطة.

تبين أن البسكويت الجاف الهش (الكراكر) المحتوي على قشور البرتقال بنسبة ١٠٪ هو الأعلى معنوياً من حيث التقبل مقارنة بنسبتي ١٥٪، ٢٠٪ وكذا الكنترول. وكانت عينات البسكويت الجاف الهش المحتوية على ١٠، ١٥٪ من قشور الموز هي الأعلى معنوياً من حيث التقبل العام في حين كانت العينات المحتوية على ١٥٪ من قشور البطاطس هي الأعلى معنوياً من حيث التقبل العام بينما كانت المعاملة المحتوية على ٢٠٪ من قشور البطاطس هي الأعلى معنوياً من حيث القرمشة.

أوضحت النتائج أن هناك علاقة طردية بين الزيادة في نسبة القشور المستخدمة والحجم النوعي لكل من الكيك والبسكويت الجاف الهش وذلك مقارنة بالعينة الضابطة (الكنترول) لكل منتج على حدة.

تبين نتائج هذه الدراسة أن قشور البرتقال والموز والبطاطس تعد بمثابة مصادر غنية بالألياف الغذائية والعناصر المعدنية، ومن ثم فإنه يوصي باستخدام هذه القشور في إنتاج مخبوزات كالكيك والبسكويت الجاف الهش (الكراكر) كمخبوزات وظيفية مهمة.