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UTILIZATION OF DEFATTED BALADI ORANGE PEEL IN PRODUCTION OF LOW CALORIC SPONGE CAKE

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ABSTRACT

Consumers are increasingly aware of diet related with health problems and those demanding natural products which are expected to be safe and health-promoting. Citrus fruits processing wastes represent a serious problem, but they are also giving sources of materials which may be utilized in the food industry because of their valuable technological and nutritional properties. The aim of this study was to use the defatted powder of Baladi orange (*Citrus sinensis*) peels in preparing of low caloric sponge cake. Defatted orange peels powder, added at different levels (0; 2.5, 5.0; 7.5 and 10%), to sponge cake mixture. The influence of using such levels of orange peels fiber on sponge cake as follow: with more adding levels of defatted orange peels powder the moisture, ether extract and total carbohydrate contents were decreased, while crude protein, crude fiber, and minerals (Fe, K, Na, Ca and P) contents were increased except zinc. Also the energy was decreased. Microbiological examination including total viable count, moulds and yeast were decreased with adding more orange peels powder. The addition levels of defatted orange peels powder increased yellowness of the prepared cakes. Sensory evaluation of manufactured cakes indicated that using of the defatted Baladi orange peels powder at 7.5% level was good enough comparing with control cake. Finally, it could be recommended that the defatted orange peels can be utilized in making sponge cakes until 7.5% substitution levels with wheat flour to solve some of health problems.
Keywords: Citrus wastes; Baladi orange; Sponge cake and Nutritional value

INTRODUCTION

Citrus are considered one of the most important fruits and orange (*Citrus sinensis)* is the predominate type of citrus grown in Egypt, which produced more than half of the total fruits production. The total annual production of Egyptian orange fruits are 1.789 million tons, which produced from 210,000 feddans (FAO, 2009). During processing and preparation of orange fruits, large qualities of wastes (about 50%) are discarded and disposal of these waste materials becomes difficult and causes serious problems (El-Bastawesy, 1999). Peel are the most important wastes remaining after the processing of orange fruits. Albedo is a white, spongy and cellulosic tissue which is the principal citrus peel component. Due to its high fiber content albedo could considered as a potential fiber source (Perez-Alvarez *et al*., 2002). Citrus wastes have high water content (80%) which make difficult to be utilized in food industries. So it is necessary, for their processing to obtain a powder (7% water) with a high fiber content as given by Fernandez-Gines, *et al*. (2004) also, they mentioned a process for the preparation of citrus fibers using the orange peel as a raw material. Hence, it

is necessary to find a feasible way to utilize the peels to have a positive environmental impact or to turn them into useful products (Manthey and Grohmann, 1996). Therefore, this study was carried out as a source of functional compounds in bakery products.

MATERIALS AND METHODS

Materials

Baladi oranges was purchased from the local fruits market at Kafr El-Sheikh City.

Methods

Preparation of orange peels

The peels were stripped with a paring knife. The orange peels were cut into small pieces using a Tiffiny Fruit processor (Model: Mini Food Processor No MC9, Tiffiny) and were sealed in glass bottles. The flavedo and albedo from four oranges were well mixed within each (flavedo and albedo) sample, separately.

Preparation of defatted orange peels powder:

Orange peels were prepared by packing fresh raw material in 2kg pouches and promptly frozen to -30 ºC until further use. After thawing (24 h/2–5ºC) the peels were pressed using an helical press to remove excess liquid prior to drying. Then drying in an oven at 50 ± 5 ºC during 24 h to improve the peels shelf life without addition of any chemical preservative. Ether extract of orange peels were extracted by petroleum ether (40º-60ºC) for 8 hours. A grinder mill and sieves were used to obtain a powder particle size of less than 0.417 mm. then, packed and stored at 4ºC until used.

Preparation of sponge cake:

The sponge cake was prepared according to El-Masry *et al*. (1990) of wheat flour (72%) , flour was replaced by defatted orange peel powders at the levels of 0, 2.5, 5.0, 7.5 and 10% for each., 200g. eggs, 120g. yoghurt, 20g baking powder, 0.5 g. vanilla and 170g. sugar, The sugar was mixed with homogenate eggs and yoghurt that containing vanilla for 20 min. using standard mixer. Wheat flour and baking powder were added in small portion and mixed for 5 min., five hundreds gram of butter were weighted into baking pans and backed at 250˚C for 30 minutes.

Analytical methods:

Moisture, ash, ether extract, crude protein, crude fiber and non protein nitrogen were determined according to the methods of A.O.A.C.(2000). Carbohydrate content was determined by differences 100 - (ash + ether extract + crude protein + crude fiber). Minerals content was determined by digestion of 0.5 g of samples in 10 ml of H_2SO_4 and one ml perchloric acid in a conical flasks (A.O.A.C, 2000). Phosphorus was determined according to Carter (1993**)**. Calcium, sodium and potassium were determined by Sherwood, flame photometer,410 according to Black (1983). Total iron and zinc were determined using atomic absorption spectrophotometer (mode Avanta) as given by Chapman and Pratt (1961).

Microbiological examination:

Samples were prepared using the methods of Anonymous (1996). Total viable bacteria, molds, yeasts, Coliform bacterial, were carried out according to the methods as given by Kiss, (1984).

Ink print texture of Cake:

Ink print texture test of sponge cake prepared from wheat flour (Control) and other mixtures was measured according to the methods described by Metwalli (1989).

Physical properties:

Sponge cake volume (Cm3) was measured by rapeseed displacement and the volume was estimated as described by the A. A. C. C. (1990), specific lightness and moisture absorption for cake of sponge cake was conducted according to Kramer and Twigg (1973) method, calculated using the following equation:

$$\text{Specific lightness} = \frac{\text{Volume of cake}}{\text{Weight of cake}}$$

The pH values of hydrolysate and fermentation broth were measured according to the A.O.A.C. (2000), using digital pH-meter (Jenway, model, 3010) with glass electrode at room temperature.

Energy values (Caloric values)

Energy values were calculated according to Lawrence (1965) using the following equation: Energy value (Kcal/100g) = (protein content × 4) + (fat content × 9) + (carbohydrate content × 4).

Daily needs of energy and protein:

Grams consumed of food to cover the daily needs of energy and protein for adult (25–50 year) were calculated using the daily requirements for adult (2900 Cal/day) as given by Anonymous (1989**).** The GDR of energy (g) calculated using the following two equations reported by Anonymous (1985**)**.

$$\text{G.D.R. of energy (g)} = \frac{\text{Energy daily requirements of adult man (2900 Cal/day)}}{\text{Energy value (Kcal/100 g food)}}$$

$$\text{G.D.R. of protein (g)} = \frac{\text{protein daily requirements of adult man (63g/day)}}{\text{protein content (63g/100 g food)}}$$

Percent satisfaction of energy and protein:

Percent satisfaction of daily requirements of energy and protein for adult man (25 – 50 year) when consumed 200 gm of sample (P.S/200) were calculated using the equation reported by Anonymous (198**5)**.

$$\text{P.S. of energy (\%)} = \frac{200 \text{ X Energy value (Kcal/100g sample)}}{\text{Energy daily requirements of adult (2900 Cal/day)}} \text{X100}$$

$$\text{P.S. of protein (\%)} = \frac{200 \text{ X g protein /100g sample}}{\text{protein requirements of adult (g/day)}} \text{X100}$$

Sensory evaluation of prepared foods:

The sensory properties of cakes containing orange peel powder were evaluated for their color, appearance, odor, texture, taste and overall acceptability on a one to ten hedonic scale, where excellent (9-10), very good (6-8), fair (4-5) and not acceptable (2-3) as described by El-Sheikh (1999).

Statistical analysis:

The data were analyzed according to Steel and Torrie (1980). One way analysis of analysis of variance (ANOVA) using the general linear models procedure was used to test for main effects where more than two variables being compared. Differences with P values ≤ 0.05 were considered to be statistically significant.

RESULTS AND DISCUSSION

Proximate chemical compositions of fresh orange peels:

The peels of Baladi orange were chemically analyzed for its contents of moisture, ash, crude protein, ether extract, crude fiber and total carbohydrates. The obtained data are presented in Table (1). The obtained results indicate that fresh orange peels contained, 76.44, 5.80, 8.85, 5.99, 62.93 and 16.44% for moisture, ash, crude protein, ether extract, crude fiber and total carbohydrates (on dry weight basis), respectively. Such findings coincide those reported by (Hamed, 1985; Silva *et al*., 1997 and El-Hendy, 2003).

Table (1): Chemical composition of fresh orange peel (on dry weight basis).

Component	(%)
Moisture	76.44
Dry Matter	23.56
Ash content	5.8
Crude protein	8.85
Ether Extract	5.99
Crude fiber	62.93
Total Carbohydrate	16.44
Minerals content (mgL100g) Iron (Fe)	2.36
Zinc (Zn)	0.07
Potassium (K)	10.20
Sodium (Na)	7.02
Calcium (Ca)	27.00
Phosphorus (P)	20.37

Regarding to minerals contents of peels of Baladi orange, it should be noted that calcium (27.00 mg/g) was the highest content of minerals. On the other hand the peels contained high amounts of phosphorus, potassium, sodium, iron and traces amount of zinc (0.07 mg/g).

Hamed (1985) noticed that the chemical composition of citrus peels are affected by many factors such as variety, place of origin, seasonal and climatic variations.

Effect of substituting orange peels powder with different levels on the chemical composition and mineral contents of sponge cake:

The effect of substituting orange peels powder with different levels (2.5, 5, 7.5 and 10%) on chemical compositions and mineral contents of sponge cake are shown in Table (2). Increasing the levels of orange peels powder caused a decreased in moisture, ether extract and total carbohydrates, while crude fiber was increased. On the same time ash content was not affected by adding orange peels powder. This results indicate to the substituting of defatted orange peels powder which cause reducing in the moisture, ether extract and total carbohydrate contents. Elsaid *et al*., (1990); Ibrahim *et al*., (1990**)** reported that many forms of dietary fiber have been added to bread and other cereal based-products. It is possible to formulate satisfactory high fiber breads (15-20% cellulose) wheat bran and oat bran are used in bread making.

Table (2): Effect of using different defatted orange peels powder levels on chemical composition of sponge cake (on dry weight basis).

	Defatted orange peels powder				
Component	**Control**	**2.5%**	**5%**	**7.5%**	**10%**
Moisture	78.09	73.86	75.00	73.60	74.20
Dry Matter	21.91	26.14	25.00	26.40	25.80
Ash content	0.72	0.75	0.77	0.78	0.80
Crude protein	2.40	2.68	2.84	3.06	3.29
Ether Extract	37.24	37.09	36.93	36.79	36.63
Crude fiber	1.36	3.01	4.69	6.32	7.98
Total Carbohydrate	58.80	56.47	54.77	53.05	51.30
Total calories(Kcal/100g)	579.96	570.41	562.81	555.55	548.03
Minerals content (mg/100g) Iron (Fe)	9.01	9.07	9.15	9.21	9.24
Zinc (Zn)	0.13	0.12	0.12	0.07	0.7
Potassium (K)	3.2	4.8	4.8	4	4
Sodium (Na)	10.7	11.5	11.5	12.3	12.3
Calcium (Ca)	13.33	14.44	15.56	15.56	16.62
Phosphorus (P)	14.7	15.30	15.81	16.01	16.71
Ca/P ratio	0.91	0.94	0.98	0.97	0.99
K/Na ratio	0.30	0.03	0.03	0.02	0.02

However, increasing levels of orange peel powder induce the mineral contents (Fe, K, Na, Ca and P) except zinc which seem to be decreased. Ishida *et al.,*(2000) stated that, one mg/day of iron is suitable for adults to maintain the daily balance of intake and excretion. Thus, all samples contain suitable amounts of iron. Shills and Young (1988) reported that if Ca/P ratio is lower than 0.5, high amount of calcium may be loss in urine, resulting a decrease in the calcium levels of bones. In this relation, Ca/P ratio of tested sponge cakes were good source of minerals required for bones formation and

when the orange peel powder levels were increasing, the Ca/P ratio was induce. A K/Na ratio in diet is an important factor in prevention of hypertension and arteriosclerosis, since K depresses and Na enhances blood pressure (Yoshimura *et al.,* 1991). Results indicated that with increasing levels of orange peels powder the K/Na ratio seem to be lower, however K/Na ratio was low and that could be cause blood pressure thus it must supplemented the sponge cake with potassium

Effect of substituting orange peels powder with different levels on some physical properties of sponge cakes:

Data in Table (3) show some physical properties of backed sponge cake produced using different substitute on levels of orange peels powder. The volume (cm^3) of the backed sponge cake was decreased with increasing the orange peels powder percentage in the formula. This effect may be attributed to the dilution of the structure forming components by sugar as clarified by Kulp *et al*., (1991). Also as shown in Table (3), substitution of wheat flour with different levels of orange peels powder caused slight decrease in the specific lightness. These findings may be related to the increment of bulking agent in cake butter as a result of adding sweeteners during the baking process as explained by Labell, (1992).

Table (3): Effect of using different orange peels powder levels on some physical properties of sponge cakes.

Orange peel powder Substitution level % of flour	Weight (Gm)	Volume (Cm3)	Specific lightness
Control	440	1250	0.352
2.5	430	1120	0.384
5.0	450	1210	0.372
7.5	455	1200	0.379
10	440	1090	0.404

Effect of substituting orange peels powder with different levels nutritive values of sponge cake:

The calculated nutritive values for protein and energy (Table 4) show that the energy value of backed sponge cakes upon of level 10% defatted orange peels powder.

Concerning to grams of cakes consumed to cover the daily needs of protein or energy (G.D.R), the results indicate that the values for protein and energy were lower than other samples. The percent satisfaction of the daily requirements of protein for adult when consuming 200 gm of cakes (P.S/200) was higher than the control sample. The PS/200 for energy of all cake samples were not noticeably differ exception the control sponge cakes. On the other hand, the energy values were decreased in all samples which containing defatted orange peels powder. These results agreement with this reported by Mckee and Latner (2000), mentioned that the citrus fiber had a low caloric content, high water holding capacity and high oil absorption properties.

Table (4): Nutritive value of cakes made using different levels of orange peels powder .

Substitution levels (%)	Nutritive values				
	Kcal/100g	G.D.R for protein (g)	P.S./200 for protein (%)	G.D.R for energy (g)	P.S./200 for energy (%)
Control	579.96	263.00	76.00	5000.00	40.00
2.5	570.41	235.00	85.00	5084.00	39.00
5.0	562.81	222.00	90.00	5153.00	39.00
7.5	555.55	206.00	97.00	5220.00	38.00
10	548.03	191.00	104.00	5292.00	38.00

G.D.R: Gram consumed of food to cover the daily needs of protein or energy for adult man.

P.S./200: Percent satisfaction of the daily requirements of protein or energy for adult man when consumed 200 gm of food.

Effect of substituting orange peels powder with different levels on Microbial counts:

The Effect of substituting orange peel powder with different levels of flour on microbial counts were listed in Table (5). Data show that substituting orange peels decreased the total viable bacteria, moulds and yeasts counts. El-Sharnouby *et,al.,* (2003) noticed that, the adding of lime or orange peel fiber lead to prolong the shelf life of toast bread during one to five days of storage period at room temperature. Also with increasing the levels of orange peels powder, the tested microbial counts was decreased. Grohmann and Baldwin, (1994) reported that citrus peel oil composition primarily limonene are very inhibitory to yeast and bacterial fermentations. On the same time the coliform bacterial was not detected in all tested samples.

Table (5): Microbial examination of sponge cakes prepared using different ratios of orange peel powder as substitutes of flour after cold stored (at 4±1 ºC for one week).

Substitution / Microorganisms	Microbial count (cfu)				
	Control	2.5%	5%	7.5	10%
Total viable count × 10^2	1.15	1.10	1.05	1.01	0.90
Moulds and yeasts count × 10^2	0.99	0.96	0.94	0.85	0.78
Coliform count × 10^2	Nil	Nil	Nil	Nil	Nil

Sponginess of cake made using defatted orange peels powder:

The sponginess of cake prepared using various levels of defatted orange peels powder was illustrated in Figures (1,2,3,4 and 5). It is clear from these figures that the cake samples made using different ratios of defatted orange peels powder as substitution of wheat flour had lower sponginess and big unregulated cells compared with control samples. In addition, the pictures in the same Figures (6,7,8,9 and 10) show that the texture of cake was affected by adding of defatted orange peels powder as replacement of wheat flour, the crump cell walls became thicker and more compact especially with these prepared using peels meal. It could be also observed that the sponginess and cells regulation of cake decreased with increasing of substitution ratio.

Fig. (1): Control sponge cake

Fig. (2): Sponge cake substituted with 2.5% of defatted orange peel powder

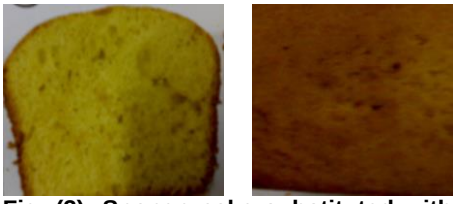

Fig. (3): Sponge cake substituted with 5% of defatted orange peel powder

Fig. (4): Sponge cake substituted with 7.5% of defatted orange peel powder

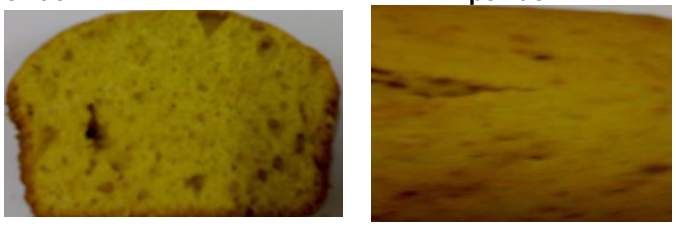

Fig. (5): Sponge cake substituted with 10% of defatted orange peel powder

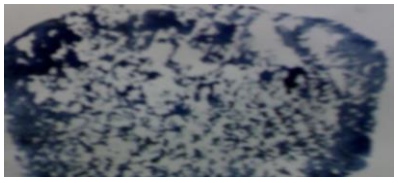

Fig. (6): Ink print of crump cell of control sponge cake

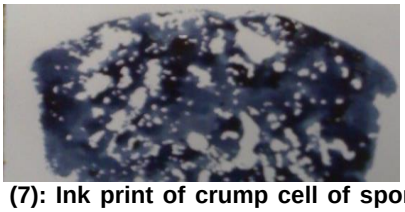

Fig. (7): Ink print of crump cell of sponge cake substituted with 2.5% of defatted orange peel powder

Fig. (8): Ink print of crump cell of sponge cake substituted with 5% of defatted orange peel powder

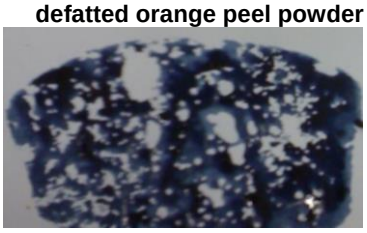

Fig. (9): Ink print of crump cell of sponge cake substituted with 7.5% of defatted orange peel powder

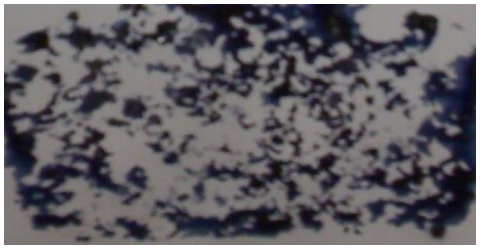

Fig. (10): Ink print of crump cell of sponge cake substituted with 10% of defatted orange peel powder

Sensory evaluation of cakes contained orange peels powder in different substitution percent of flour:

Sensory evaluation is still the most satisfactory way of assessing the quality of many products. In all foods, organoleptic tests are generally the final guide to its quality from the consumer point view. Organoleptic evaluation of cakes usually covers color, appearance, taste, odor and less extent its texture (El-Sheikh, 1999). In this investigation sponge cakes in all treatments, immediately after processing were evaluated organoleptically by 20 panelists. Both of Organoleptic properties were evaluated in comparison with cake prepared with wheat flour only.

Results (Table 6) indicate that values as mean of the scores given by 20 panelists based on a 9-point scale.. From the tabulated results, it could be noticed that data indicate that sponge cakes produced with wheat flour (control) and this with a substitute ratio of (2.5%) have relatively the best appearance, color, taste, odor, texture and overall acceptability when comparing with the other manufactured cakes The statistical analysis supports these findings at $P \leq 0.05$.

Table (6): Organoleptic properties of fresh cakes prepared using different ratios of orange peels powder as substitutes of flour.

Substitution (%)	Organoleptic score					
	Color	Texture	Crumb color	Odor	Taste	Overall acceptability
Control [a]	8.6 ± 0.04[a]	9.3 ± 0.043[a]	8.7 ± 0.18[a]	8.0 ±0.04	8.3 ± 0.04	8.58[a]
2.5[b]	8.6 ± 0.03[ab]	8.6 ± 0.02[b]	8.6 ± 0.32[a]	8.6 ± 0.02	8.3 ± 0.04	8.54[ab]
5.0[b]	8.7 ± 0.03[ab]	8.5 ± 0.03[ab]	8.1 ± 0.26[ab]	8.6 ±0.03	7.1 ± 0.01	8.2[b]
7.5[abc]	8.6 ± 0.04[ab]	8.0 ± 0.04[ab]	8.1 ± 0.03[ab]	7.7 ±0.06	7.6 ± 0.08	8.00[c]
10[c]	8.0 ± 0.04[b]	7.0 ± 0.04[b]	7.6 ± 0.04[b]	8.1 ±0.04	7.4 ± 0.05	7.62[d]
Significance	*	**	*	NS	NS	*

****: P ≤ 0.01. *: P ≤ 0.05. NS: Non significant**
(A) and (B): comparison of means of scores by sweetener type.
A, b and c: comparison of means of scores by substitute ratio.
Overall acceptability = (Appearance + Texture + Color + Odor + Taste) divided by 5.

The obtained results are in agreement with those obtained by El-Sheikh (1999). Regarding to the attained results, it could be concluded that, all these products had scores more than 5, showing that all samples were organoleptically accepted.

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استخدام قشور البرتقال البلدي لإنتاج كيك إسفنجي منخفض السعرات الحرارية

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يزداد قلق المستهلكين من المشاكل الصحية التي تحدثها بعض الأغذية وبناء على ذلك يكون الاتجاه إلى استهلاك المواد الغذائية الطبيعية التي تكون أكثر أمانا على الصحة . وتمثل مخلفات صناعة الموالح مشكلة كبيرة لدى المنتجين ولكنها تعتبر مواد يمكن استخدامها لما لها من خواص تكنولوجية وتغذويه جيدة وتهدف هذه الدراسة إلى تقليل المشاكل الصحية للأغذية عالية السعرات الحرارية عن طريق استخدام مخلفات صناعة البرتقال البلدي (قشور البرتقال) والذي تم تحويله في هذه الدراسة إلى مسحوق منزوع الدهن ثم تم تحليله لمعرفة خواصه الكيماوية والطبيعية ، وقد أوضحت الدراسة أن مسحوق قشور البرتقال المنزوع الدهن الذي تم استخدام في تصنيع الكيك الأسفنجي بنسب استبدال ٢,٥ ، ٥ ، ٧,٥ و ١٠% مع دقيق القمح والذي تم خلطة لعمل الكيك أدى إلى ما يلي : بزيادة إضافة نسب مسحوق قشور البرتقال المنزوع الدهن لوحظ حدوث انخفاض في محتوى الرطوبة ومستخلص الدهن والكربوهيدرات بينما حدث زيادة في نسب البروتين والألياف الخام والمحتوى من العناصر المعدنية (الحديد ، البوتاسيوم ، الصوديوم ، الكالسيوم والفسفور) بينما انخفض محتوى العينات من عنصر الزنك . كما أوضحت النتائج حدوث انخفاض في مستويات السعرات الحرارية بزيادة نسب الاستبدال . كما صاحب ذلك بانخفاض في المحتوي الميكروبي (العدد الكلي للبكتريا ، الفطريات والخمائر) ولم يلاحظ وجود بكتريا Coliform وعلى الجانب الأخر أوضحت نتائج الاختبارات العضوية الحسية بأن الكيك المنتج بنسب خلط حتى ٧,٥% تكون مقبول للمستهلك . وتوصي الدراسة باستخدام قشور البرتقال المنزوعة الدهن في تصنيع الكيك الأسفنجي وتعتبر نسب الاستبدال حتى ٧,٥% مقبولة لدى المستهلك وأمنه صحيا .