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ANTIMICROBIAL, ANTIOXIDATIVE EFFECTS OF CAROB POWDER AND ITS EFFECT ON CAKE QUALITY CHARACTERISTICS

BY

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ABSTRACT

Fiber intake is commonly lower than recommended .In consequence the development of foods with high fiber content should be desirable. The potential use of carob (ceratonia siliqual), as a fiber enriching agent in cakes making, is reported. Carob powder was tested to evaluate its antimicrobial activity on some microorganisms. Cake samples were made with different ratios of carob powder (0, 2.5 %, 5% and 7.5% of sucrose was substituted with carob powder) .Dough rheology, chemical, physical properties of the resultant cakes were determined and also the effect of storage for 21 days at room temperature on fat stability, microbial counts and sensory evaluation of cake samples were also studied. The results indicated that use of 4% carob water extract was more effective on the growth of mould and yeast followed by E. coli and B. cereus. The addition of carob fiber (2.5 % and 5 %) mainly increased the maximum viscosity, degree of maximum viscosity and degree of conformation compared with control dough.The total dietary fiber of the cakes containing carob powder were higher than control cakes (no added carob powder). Specific volume increased by increasing the levels of carob powder. Cakes containing 2.5and 5% carob powder had lighter colour than those of control cakes and cakes containing 7.5% carob powder. By the third week, cakes with 5, 7.5 % carob powder were more freshness in comparison to control and cakes containing 2.5% carob. By the third week of storage at 27 ± 3oC, cakes containing 5, 7.5% carob powder were still not rancid, but control cakes and cakes containing 2.5% carob powder were rancid and still acceptable. Carob powder improved the fat stability of cakes. After 21 days of storage, the total bacterial count in control cakes increased to 2 x103 while in cakes containing 2.5%, 5% and 7.5% carob powder bacterial counts were 2 x102, 1.4x102, and 8x 10 cfu / g, respectively . Addition of carob powder retarded yeast and moulds compared with control (no added fiber). The individual addition of 2.5% and 5% carob powder improved significantly all sensory attributes compared with control cakes and cakes containing 7.5% carob powder. It could be concluded that the addition of carob powder to cakes were act as antioxidant and antimicrobial for butter cakes during 21 days of storage .The addition of 2.5% and 5% carob powder extend the shelf-life and quality attributes of cakes by reducing the incidence of staleness .

Key Words: Carob powder, antimicrobial and antioxidative agents, cake, physical properties, rheological properties, TBA, acid value, sensory attributes, staling, specific volume.

INTRODUCTION

Fiber's role in achieving health and preventing disease is not entirely clear. For example, in recent months a number of studies examining the relationship of high- fiber foods and colorectal cancer yielded contradictory results. Other potential benefits from fiber include protection against duodenal and breast cancers, and improvement of immune function. Therefore, the ingredient cost of a food product may go up when you add fiber. However, fibers can provide many functional benefits other than fortification. These added benefits (that lead to improved quality) are often more than enough to offset any ingredient cost differential. A newer entry in the cellulose – fiber category is a patented carob fiber from Nutrinova, Somerset, NJ- Marketed as the Mediterranean fiber. It is an extract of carob- fruit pulp (also called St- Johan' s bread) that is 80 % insoluble fiber and is rich in lignin and other phytonutrient. Research has shown the presence of antioxidant activity and demonstrated a cholesterol- lowering effect from carob- fiber consumption (Angela, 2003). Another component of the carob fiber, pinitol naturally occurs at about one percent, a very high level. Pinitol, a type of inositol, has been shown to regulate blood glucose. Caromax has the potential to be a natural blood glucose regulator, especially for diabetics (Laura, 2002). Researchers found that, the carob- derived fiber was superior antioxidant in comparison to wheat or oat bran. The fiber' s free- radical fighting abilities also translate into benefits for product shelf- life, since the ingredient helps to inhibit fat oxidation (Susan, 2004).

Carob powder has been high content in natural sugars (sucrose, glucose and fructose) and fiber but a low caloric content, due to its low- fat and high fiber content. It is also rich in vitamins (A, B_1, B_2, D) and minerals (iron, calcium, phosphorus and magnesium) as well remarkably high potassium content (1.2 % - 1.5 %) contributes to balancing occidental diets excessively rich in sodium. Carob powder is an ideal cocoa substitute and sugar replace for chocolate and confectionery recipes. Carob powder is a product with a naturally sweet flavor (sweetener power 0.5 – 0.6) which is used to improve aroma and taste in numerous food products. Applications for this unique dietary fiber include baked goods, bars, snacks, cereal, and dairy products. Usage level varies, depending on the application, but range from 1 – 5 % on a finished product basis. Caromax can extend the shelf life of baked goods by reducing the incidence of staleness and inhibiting microbiological growth. In baked goods application, caromax can reduce the stickiness of the dough, which may make the dough suitable for automated industrial production (Susan, 2004). With an excellent water – binding capacity anti – caking properties, it can prolong a product' s shelf life. Other benefits texture improvement, increased flow ability, and enhanced coloring, quality and freshness (Linda, 2003).

Cake manufactures face a major problem of lipid oxidation and mould growth which limits the shelf life of their products. The use of antioxidants and preservatives can reduce this problem. Dietary antioxidant may also help counter the detrimental effects of oxygen free radicals, formed during normal metabolism and form external factors which are implicated in the development of cancer,

premature aging, cardiovascular and other degenerative diseases (Lean and Mohamed, 1999).

The aim of the present research was to determine the potential use of carob powder as a fiber enriching agent on the final quality characteristics of the resulting cakes. Antimicrobial and antioxidative effect of such dietary fiber was also studied.

MATERIALS AND METHODS

1- Materials

1.1- Carob powder:

A commercial dried carob (*Ceratonia siliqua* L.) was obtained from local market. Pulp was separated manually from seeds, and it was finally ground.

1.2- Microbial strains:

Cultures of *B. cereus* ATCC 14085, *Candida lipolytica* NRRL 1095, *A. niger* ATCC 102 and *E. coli* DSM 5212 were obtained from the Egyptian Microbial Culture Collection (EMCC) at the Microbial Resource Center (Cairo, MIRCEN), Faculty of Agriculture, Ain Shams Univ. Egypt.

1.3- Cake ingredients:

Wheat flour 72 % extraction was obtained from Cairo South Company of milling (El- Haram Milling). Fat (palm oil), fresh eggs, baking powder (commercial grade), dried milk and vanillia were collected from local market.

2- Methods:

2.1- Cake preparation:

Cake samples were made according to the method of Bennion and Bamford (1973).

The control sample contained wheat flour (100g), sucrose (85g), dried milk (3g), fat (55g), fresh whole egg (85g), baking powder (3.8g) and vanillia (0.6g). To study the effect of use of carob powder on cake quality 2.5 %, 5 % and 7.5 % of sucrose was substituted with carob powder. Cake was prepared by creaming of fat, and then sugar was added to the creamed fat at medium speed. Whole eggs and vanillia were then slowly added at low speed to avoid curdling and this was followed by continuous mixing for 2 min. Sifted flour and baking powder were then gently added on the sugar- fat egg mixture and mixing for 5 min. The batters were baked at 180 °C for 30 min. The cakes were cooled, packed in polyethylene bags and stored at room temperature (27 ± 3 °C) for 21 days. Storage studies were done with triplicate samples for each trial. The cakes were analysed at 0, 7, 14 and 21 days.

2.2- Dough characteristics:

Rheological properties of cake dough were determined by Amylograph at the Egyption Baking Technology Center (EBTC) according to the A.A.C.C (1996).

2.3- Chemical analysis:

Moisture, protein, fat and ash contents of different samples were determined according to the methods described in **A.O.A.C. (1990).** Soluble, insoluble and total dietary fiber contents of carob powder were determined by an enzymatic gravimetric method (Prosky *et al.*, 1988).

Total phenols were determined according to the method described by (Swain and Hillis (1959).

2.4- Physical analysis:

2.4.1- Weight, Volume and Specific volume:

The weight and volume of cakes were measured according to (Randez – Gil, *et al.*, 1995).

2.4.2- Staling:

Staling was periodically measured throughout the days of storage. The samples were cut into small pieces, dried at 130 °C for 4 hour and then ground. The cake staling was measured by alkaline water retention capacity (AWRC) according to the method applied by Mahmoud and Abou- Arab (1989).
The freshness values during storage were calculated as follows:

$$\frac{\text{\% water retention of storage sample}}{\text{\% water retention of fresh sample}} \times 100$$

2.4.3- Color evaluation:

Cakes color differences were determined using a Spectro – Colorimeter. Color scale (Hunter, Lab. Scan XE, Germany) was calibrated with a white standard title of Hunter Lab. Color Standard: X = 77.26, Y = 81.94 and Z = 88.14.

2.5- Fat stability:

Acid value and thiobarbituric acid (TBA) of oil extracted from different cake samples were determined according to the method described by A.O.A.C. (1990).

K_{270} and K_{232} extinction coefficients (absorption of 1 % solution in cyclohexane at 270 and 232 nm, respectively, with 1 cm of pass length) were measured using a UV spectrophotometer (Hewlett Packard, Model 8452A) according to Garcia *et al.*, (2001).

2.6- Microbiological evaluation:

The microbiological study comprised the determination of total bacterial counts on nutrient agar at 32° C for 48 h.

Staphylococcus aureus was detected and enumerated on Baird- parker medium and incubated at 32° C for 48 h. according to Blair *et al.*, (1967).

Salmonella was determined on bismuth sulphite agar and incubated at 35° C for 48 h. according to Marvin (1984).

Yeast and Mold were enumerated according to Marshall (1992) using oxitetracycline glucose yeast extract agar at 25° C for 5 days.

2.6.1- Antimicrobial activity of carob powder:

The disk diffusion method of Barry and Thornsberry, (1985) was used for detecting the antimicrobial activity of 4% carob water extract on the growth of *B. cereus* ATCC 14085, *Candida lipolytica* NRRL 1095, *A. niger* ATCC 102 and *E. coli* DSM 5212 . Water carob extract was filterated through Whatman No. 1 filter paper. The resulting filtrate was sterilized through a 0.45 um pore size filter, collected in a sterile vial and stored at 4° C until used.

To determined the antimicrobial activity of water carob extract the microbial strains were inoculated on plates containing the suitable media. Sterile discs were dipped in the appropriate water carob extract, blotted and then placed on the surface of inoculated plates. The plates were incubated at the optimum temperature for 24 h. After 24 h. of incubation, the plates were examined and the diameters of the inhibition zones were observed and measured in millimeters.

2.7- Organoleptic evaluation:

The organoleptic properties of cake samples assessed by a regular taste panel comprised the staff- members of the Food Science Department, Faculty of Agriculture, Ain Shams University. Fresh cake quality was determined according to the method described in A.A.C.C. 1996.

2.8- Statistical analysis:

Experimental data were analyzed for variance (ANOVA) and significant differences among the means were determined by Duncan's multiple – range test using the Statistical Analysis System (SAS, 1996) computer program.

RESULTS AND DISCUSSION

1- Chemical composition of carob powder:

The contents of moisture, protein, fat, ash and total carbohydrates of carob powder used in this investigation are listed in Table (1). The moisture content of carob powder was 5.6 % while protein, fat, ash and carbohydrate were 6.46 %, 0.69 %, 2.97 % and 89.99 %, respectively.

The contents of total dietary fiber, insoluble and soluble dietary fiber were 86.2 %, 76.2 % and 10.0 %, respectively. Results in Table (1) show that polyphenols content (as gallic acid) of carob was 1023 ppm. These results are in agreement with those obtained with Wang *et al.*, (2002) and Linda, (2003) who found that carob fiber contained 85.0 %, 74.0 % and 11.0 % of total dietary fiber. insoluble dietary fiber and soluble dietary fiber respectively They also reported that carob fiber is composed mainly of lignin and poly phenol

Therefore, carob powder is considered as an important source of dietary fiber with a nearly un appreciable fat content

Table (1): Chemical composition (mean ± SE), on dry basis of carob powder

Moisture* %	Protein %	Fat %	Ash %	Carbohydrates %	Total dietary fiber	Insoluble dietary fiber	Soluble dietary fiber	Polyphenols (ppm) as gallic acid
5.6±0.03	6.46± 0.1	0.69± 0.23	2.97± 0.30	89.88	86.2	76.2	10.0	1023

*: On wet basis

2- Antimicrobial effect of carob:

Inhibition zone diameters of indicators microbial strains resulted from inoculation of strains on the suitable media treated with carob water extract, after 24 h incubation were illustrated in Fig (1). It was found that *A. niger* proved to have larger inhibition zone than other strains.

A. niger, Candida lipolytica, E. coli and *B. cereus* inhibition zones diameters were 23, 21, 19 and 18 mm, respectively. The above data cleared obviously that the use of 4 % carob water extract was more effective on the growth of mould and yeast followed by *E. coli* and *B. cereus*. This behavior is due to the presence of phenolic substances which could be used as natural antioxidant and antibacterial agent (Negi and Jayaprakasha 2003).

3-Rheological properties of cake-dough containing different concentrations of carob powder:

The addition of carob fiber (2.5 % and 5 %) mainly increased the maximum viscosity, degree of maximum viscosity and degree of conformation compared with control as shown in Table (2). This might be attributed to the higher water holding capacity (WHC) of fiber sources (Galal, 1998).

These results were coincided with that of Schneeman (1989) and Almana and Mahmoud (1994) who published that, the pectines, lignins, mucilages, to a limited extend hemicellulose, wheat bran, fine and coarse date seed have high WHC hydration of the fibers results in formation of gel matrix. This can raise the viscosity of dough.

Table (2): Amylograph analysis of cake- dough containing different ratios of carob powder:

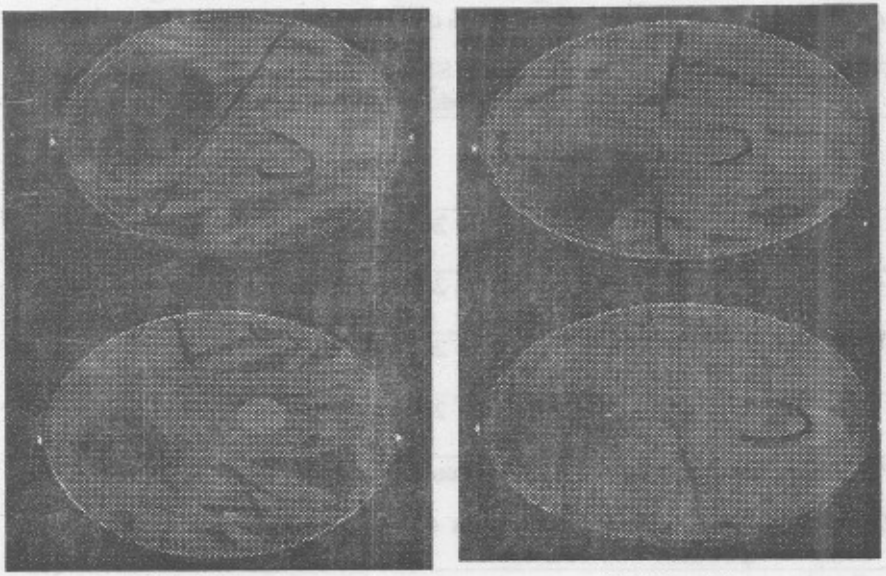
Sample Carob powder	Maximum viscosity	Degree of maximum viscosity (°C)	Degree of conformation (°C)
0.0 %	520	83	56
2.5 %	630	92	62
5.0 %	670	90	63
7.5 %	520	83	56

4- Chemical analysis of cake:

Obtained data of the chemical analysis of cakes made with (carob free), different ratios of carob (2.5, 5, and 7.5%) are presented in table (3).The moisture content of cake ranged from 18.99 to 20.321%. There were no significant differences ($p>0.01$) in fat and protein contents of control and cakes contained

carob powder. The higher content of ash was observed in cakes containing (5.0 and 7.5% carob). Carbohydrate content decreased by increasing the ratio of carob powder in cakes. Due to the substitution of sugar by carob powder, carbohydrate content of cake containing 7.5% carob powder was 61.68 while it was 62.49% for control cake (carob free).

(1): *Asp. niger* (3): *Candida lipolytica*



(2): *B. cereus* (4): *E. coli*

Fig (1): Effect of 4% carob water extract on inhibition zone diameter (mm) of (1) *Asp. niger*, (2) *B. cereus* (3) *Candida lipolytica*, and (4) *E. coli*

As can be seen in Table (3), the total dietary fibre of the cakes made with different ratios of carob powder were higher than that of control cakes (no added carob powder). Cake contained 7.5 % carob powder showed 8.95 % fiber content compared to 2.5 % for control sample.

5- Physical properties of cakes containing different concentration of carob powder:

5-1- Specific volume and color:

The physical properties of produced cake at zero time are presented in Table (4). It is generally noticed that, the difference in means of the specific volume between cakes containing different ratios of carob powder and control cakes were significant ($p<0.01$). Specific volume increased by increasing the levels of carob powder. It reached 2.39, 2.44, and 2.33in case of cakes containing 2.5, 5and 7.5%carob powder respectively. While it was only 1.9 in control cakes .Specific volume is indication of cake lightness which means that the higher values of specific volume the lighter cake is. This in turn positively affects both texture and tenderness (El-azab, and bothayna, 1997). Colour as a matter of visual perception is an important consideration in food product development because

food colour and appearance are usually the first impressions to register in the consumer's mind .Analysis of cakes for (L*) lightness, (a*) redness, and (b*) yellowness characteristics in Table (4) shows significantly ($p<o.o1$) that cakes containing 2.5 and 5% carob powder were lighter colour than that of control cakes and cakes containing 7.5% carob powder. On the other hand, control cakes were lighter than cakes containing 7.5% carob powder .The higher value of redness was in cakes containing 7.5% carob (7.89) while the higher value of yellowness was in cakes containing 2.5% carob.

Table (3): Chemical analysis (mean ± SE), on dry basis of Cakes containing different ratio of carob powder.

Samples Carob powder %	Moisture* %	Protein %	Fat %	Ash %	Carbohy-drates**	Fiber %
Control sample	18.991± 0.221	9.871± 0.199	26.322± 0.110	1.321± 0.110	62.491± 0.206	2.5 ± 0.022
2.5 %	19.132± 0.310	10.031± 0.201	26.340± 0.370	1.395± 0.201	62.240± 0.201	4.65 ± 0.011
5.0 %	19.314± 0.203	10.195± 0.300	26.366± 0.370	1.471± 0.200	61.986± 0.191	6.80 ± 0.031
7.5 %	20.321± 0.351	10.331± 0.221	26.443± 0.311	1.550± 0.170	61.680± 0.180	8.95 ± 0.120

*: On wet basis **: Calculated by difference

Table (4): Physical quality of Cakes containing different ratios of carob powder:

Samples Carob powder %	Weight	Volume	Specific volume	Lightness L	Redness a	Yellowness b
0.0 %	275.19^{A}	521.66^{A}	1.90^{C}	52.27^{C}	5.54^{C}	16.89^{B}
2.5 %	202.25^{c}	485.00^{A}	2.39^{AB}	68.83^{A}	0.97^{D}	31.62^{A}
5 %	240.64^{B}	588.33^{A}	2.44^{A}	54.70^{B}	5.85^{B}	14.26^{C}
7.5 %	239.80^{B}	558.33^{A}	2.33^{B}	46.96^{D}	7.89^{A}	11.79^{D}

A, B, ...Means with the same superscript letter within the same parameter are not significantly different ($p > 0.01$).

5-2 Staling:

Cakes staling were measured and the obtained data were recorded in Fig. (2) It was clear that during storage at room temperature for 21 days, freshness of the resultant cakes either control or cakes containing differences ratios of carob decreased by increasing time of storage. This result is in full agreement with Shukla (1995). The decrement in freshness was more pronounced in case of control (carob free). The percentage decrement in freshness after 7 days can be ranked in a descending order as follows : 95.97, 95.28, 92.66, and 91.83 in case of cakes containing (2.5, 5, 7.5, and 0 %) carob respectively . By the third week, cakes containing (5, 7.5 %) carob powder had higher freshness in comparison to control and cakes containing 2.5% carob .Carob powder leading to extend shelf life, because of its higher water-binding capacity, it can extend the shelf life of baked goods by reducing the incidence of staleness . (Susan, 2004).

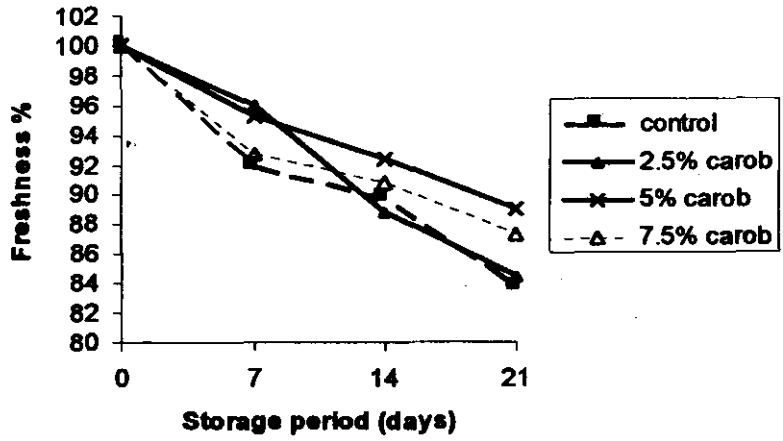


Fig. (2): Freshness % of cakes containing different ratios of carob powder.

6- Stability of cake lipids:

The stability of cakes lipids and consequently different cakes which prepared with addition of different ratios of carob powder (0, 2.5, 5, and 7.5%) were determined periodically at intervals till 21 days at ambient temperature. Lipids of stored cakes were analyzed for their Thiobarbituric acid value (TBAV), Acid value (AV), K_{232}, and K_{270} to evaluate the efficiency of carob powder as antioxidant agent.

The differences in mean of TBAV, AV, k_{270} and k_{232} between experimental and control cakes were significant ($P<0.01$) from the zero time until the 21 days of storage (Table 5). During the 21 days of storage TBAV for all cakes increased with time. TBAV less than 8 u mol (0.576 mg) kg^{-1} sample are considered not rancid whereas values of 9-20 u mol (0.65-1.44 mg) kg^{-1} sample are regarded as rancid but still acceptable, and values greater than 21 u mol (1.5 mg) kg^{-1} sample are said to be rancid and unacceptable (Ke, *et al.* 1984). The values in Table (5) indicate that all the cakes were not rancid in the first week. By the second week, control cakes were close to being rancid but still acceptable. By the third week, cakes containing 5, 7.5% carob powder were still not rancid, but control cakes and cakes containing 2.5% carob powder were rancid and still acceptable .Therefore it appears that carob powder can possibly extend the shelf-life of the cakes to more than 21 days, as compared with 14 days for control cakes. Data in Table (5) indicate that the acid value of cakes lipids increased during 21 days of storage for all samples. The lowest acid values were found in cakes containing 7.5% carob powder followed by cakes containing 5% carob powder.

The specific extinction at 232 nm wavelength, k_{232}, is related to the primary oxidation rate of fat, while k_{270} and ΔK are related to the secondary oxidation rate (Ranalli, *et al.* 1998). Concerning k_{232} and k_{270} data presented in Table (5) show that the k_{232} and k_{270} significantly increased during the storage

period in all cakes . The lowest ($P<0.01$) k_{232} and k_{270}were found in cakes containing carobs compared with control cakes. These findings are in accordance with (Susan, 2004) .They found that when using Trolox Equivalent Antioxidative Capacity (TEAC) methodology researchers the carob-derived fiber was a superior antioxidant in comparison to wheat or oat bran .The fiber's free – radical fighting abilities also translate into benefits for product shelf-life, since the ingredient helps to inhibit fat oxidation .The effect of carob fiber on fat may be due to the naturally high level of polyphenols (Laura, 2002) . Phenolic antioxidants are proton donors which act as inhibitors for radical chain reactions on autoxidation of organic substrates (Lean and Mohamed, 1999)

Table (5): Changes occurred in Thiobarbituric acid value (TBAV)*, Acid value (AV), k_{232} * and k_{270} $^{\Delta}$ of cake lipids during storage .**

Parameters	Samples Carob powder %	Storage period (days)			
		Zero	7	14	21
TBA	0.0	0.189^{Ad}	0.316^{Ac}	0.607^{Ab}	0.777^{Aa}
	2.5	0.182^{Ad}	0.294^{ABc}	0.491^{Bb}	0.736^{Aa}
	5.0	0.148^{Bd}	0.272^{Bc}	0.381^{Cb}	0.514^{Ba}
	7.5	0.143^{Bd}	0.212^{Cc}	0.319^{Cb}	0.489^{Ba}
AV	0.0	1.72^{Ab}	2.318^{Ab}	2.08^{Ab}	3.61^{Aa}
	2.5	1.72^{Ad}	2.283^{Ac}	2.57^{Ab}	3.38^{Ba}
	5.0	1.59^{Bd}	1.89^{Bc}	2.35^{Ab}	2.65^{Ca}
	7.5	1.69^{Bc}	1.80^{Cbc}	2.11^{Aa}	1.90^{Db}
K_{232}	0.0	1.66^{Ad}	2.15^{Ab}	2.02^{Bc}	2.48^{Aa}
	2.5	1.39^{Bc}	2.07^{Ab}	2.12^{Ab}	2.36^{Ba}
	5.0	1.39^{Bc}	1.77^{Bb}	1.72^{Cb}	2.35^{Bca}
	7.5	1.44^{Bd}	1.71^{Bc}	1.98^{Bb}	2.27^{Ca}
K_{270}	0.0	0.249^{Ad}	0.687^{Ac}	0.884^{Ab}	1.29^{Aa}
	2.5	0.182^{bd}	0.577^{Bc}	0.724^{Bb}	0.994^{Ba}
	5.0	0.105^{Cd}	0.481^{Cc}	0671^{Cb}	0.815^{Ca}
	7.5	0.09^{Dd}	0.207^{Dc}	0.337^{Db}	0.701^{Da}

* = as O.D at 538 nm ** =as mg K OH alcohol / g oil

° as O.D at 232 nm $^{\Delta}$ = as O.D at270 nm

a, b.....Any two means have the same small letter within the same row have no significant difference ($p > 0.01$)

A, B.....Any two means have the same capital letter within the same storage time for the same parameter have no significant difference ($p > 0.01$)

7-Microbiological evaluation of cakes

Total plate counts, Staphylococcus, Salmonella, Yeast and Mould counts of different cakes were followed up during storage period at ambient temperature. From the data in Table (6) it could be observed that all samples of cakes were free from Staphylococcus and Salmonella. The initial bacterial counts in cakes ranged from $1.1x10^2$ to $2\ x10^2$ cfu / g. After 21 days of storage, the total bacterial count in control cakes increased to $2\ x10^3$ while in cakes containing 2.5%, 5% and 7.5% carob powder bacterial counts were $2\ x10^2$, $1.4x10^2$, and 8x 10 cfu / g,

respectively .Yeast and moulds were not appeared after backing (zero time) in all cakes, but appeared after 7 days of storage only in control cakes and cakes containing 2.5% carob powder. After 14 days of storage, yeast and moulds were appeared in all cakes samples and their counts, ranged from 1x 10 to $1.4x10^3$ cfu / g. At the end of storage period, it could be observed that addition of carob powder generally retarded growth of Yeast and Moulds in cake samples compared with control (no added fiber).

The decrease in Yeast and Molds counts increased by increasing the concentration of carob powder during storage of cakes this results are coincided go in parallel with those of Salama, 2002 . Carob fiber contains phenolic compounds (Susan, 2004) which may act as antimicrobial. At a pharmacological level the tannic substances present in vegetables including carob constitute which act as local antihemorrhagic as well antimicrobial actions (Alim carat, 2004).

Table (6): Microbiological analysis of cakes made with different ratios of carob powder during storage period at room temperature

Samples Carob powder %	Storage period (days)			
	Total count	Staph. aureus	*Salmo sp.*	Yeast & Mold
		0		
0.0%	$2 x10^2$	-	-	-
2.5%	$2 x10^2$	-	-	-
5%	$1.1 x10^2$	-	-	-
7.5%	$1.3 x10^2$	-	-	-
		7		
0.0%	$2.8 x10^2$	-	-	$2 x10^2$
2.5%	$8 x10^2$	-	-	$2 x10^2$
5%	$3 x10^2$	-	-	-
7.5%	$1.8 x10^2$	-	-	-
		14		
0.0%	$6 x10^3$	-	-	$1.4 x10^3$
2.5%	$9.4 x10^2$	-	-	8 x10
5%	$7 x10^2$	-	-	1 x10
7.5%	$2.1 x10^2$	-	-	1 x10
		21		
0.0%	$8 x10^3$	-	-	$2 x10^3$
2.5%	$1 x10^3$	-	-	$2 x10^2$
5%	$9 x10^2$	-	-	$1.4 x10^2$
7.5%	$4 x10^2$	-	-	8 x10

8- Changes occurred in sensory evaluation of cakes during storage:

Data in Table (7) represent the mean scores for volume, shapeliness, crust character, crumb color, brightness crumb, texture, softness, aroma, and eating quality for prepared cakes made with different concentration of carob powder The data show that, there were significant differences between the control cakes, cakes containing 7.5% carob and those containing 2.5%, 5% carob for volume, shapeliness, and crust character The individual addition of 2.5% and

Table (7): Sensory evaluation of cakes made with different ratios of carob powder during storage period at room temperature

Character assessed	Carob powder%	Storage period			
		0	7	14	21
Volume (10)	0.0	8.3^{Ba}	8.0^{Ba}	6.4^{Bb}	5.5^{Bc}
	2.5	9.1^{Aa}	8.7^{Aa}	7.4^{Ab}	7.1^{Ab}
	5.0	9.4^{Aa}	8.8^{Ab}	7.7^{Ac}	7.2^{Ad}
	7.5	8.5^{Ba}	7.4^{Cb}	6.2^{Bc}	5.4^{Bd}
Shapelinees (10)	0.0	8.7^{ABa}	7.2^{Bb}	6.3^{Bc}	5.9^{Bc}
	2.5	9.1^{Aa}	8.3^{Ab}	7.4^{Ac}	7.0^{Ad}
	5.0	9.2^{Aa}	8.6^{Ab}	7.4^{Ac}	7.1^{Ac}
	7.5	8.5^{Ba}	7.6^{Bb}	6.2^{Bc}	5.9^{Bc}
Crust character (10)	0.0	8.9^{Aa}	7.4^{Bb}	6.2^{Bc}	6.0^{Bc}
	2.5	8.9^{Aa}	8.8^{Aa}	7.6^{Ab}	7.0^{Ac}
	5.0	8.7^{ABa}	8.9^{Aa}	7.3^{Ab}	7.1^{Ab}
	7.5	8.3^{Ba}	7.6^{Bb}	6.3^{Bc}	6.0^{Bc}
Crumb color (10)	0.0	9.0^{Aa}	7.9^{Ab}	7.0^{Bc}	6.0^{Bd}
	2.5	8.5^{ABa}	8.4^{Aa}	7.5^{ABb}	7.1^{Ab}
	5.0	7.9^{BCab}	8.4^{Aa}	7.6^{Abc}	7.1^{Ac}
	7.5	7.5^{Ca}	7.0^{Ba}	7.0^{Ba}	6.0^{Bb}
Brightness of crumb (10)	0.0	8.5^{Aa}	7.5^{Bb}	6.1^{Bc}	5.6^{Bd}
	2.5	8.7^{Aa}	8.4^{Aa}	7.0^{Ab}	7.0^{Ab}
	5.0	9.0^{Aa}	8.4^{Ab}	7.1^{Ac}	7.1^{Ac}
	7.5	7.7^{Ba}	6.9^{cb}	6.2^{Bc}	5.7^{Bc}
Texture (10)	0.0	9.2^{Aa}	7.0^{Cb}	6.0^{Bc}	5.5^{Bd}
	2.5	9.2^{Aa}	7.7^{Bb}	7.4^{Abc}	7.0^{Ac}
	5.0	9.2^{Aa}	8.4^{Ab}	7.5^{Ac}	7.1^{Ac}
	7.5	8.5^{Ba}	6.8^{Cb}	6.0^{Bc}	5.5^{Bd}
Softness (10)	0.0	9.0^{BCa}	7.2^{Cb}	6.5^{Bc}	5.7^{Bd}
	2.5	9.4^{ABa}	7.8^{Bb}	7.2^{Ac}	7.2^{Ac}
	5.0	9.6^{Aa}	8.5^{Ab}	7.4^{Ac}	7.2^{Ac}
	7.5	8.8^{Ca}	7.6^{BCb}	6.9^{ABc}	5.7^{Bd}
Aroma (15)	0.0	13.2^{Ba}	11.4^{Bb}	8.0^{Bc}	5.9^{Bd}
	2.5	14.4^{Aa}	12.4^{Ab}	11.2^{Ac}	10.6^{Ad}
	5.0	14.8^{Aa}	12.7^{Ab}	11.7^{Ac}	10.3^{Ad}
	7.5	13.4^{Ba}	11.1^{Bb}	7.5^{Bc}	5.8^{Bd}
Eating Quality (15)	0.0	14.2^{Aa}	11.2^{Bb}	8.9^{Bc}	6.4^{Bd}
	2.5	14.7^{Aa}	12.6^{Ab}	11.6^{Ac}	10.5^{Ad}
	5.0	14.6^{Aa}	12.9^{Ab}	12^{Ab}	10.8^{Ac}
	7.5	13.2^{Ba}	11^{Bb}	8.8^{Bc}	5.8^{Bd}
Total scores(100)	0.0	89.0^{Ba}	74.7^{Cb}	61.4^{Bc}	52.5^{Bd}
	2.5	91.0^{Aa}	83.1^{Bb}	74.3^{Ac}	70.5^{Ad}
	5.0	92.3^{Aa}	85.5^{Ab}	76^{Ac}	71.0^{Ad}
	7.5	84.4^{Ca}	73^{Cb}	61^{Bc}	51.7^{Bd}

a, b . . . .Any two means have the same small letter within the same treatment have no significant difference ($p>0.01$)

A, B. . . .Any two means have the same capital letter within the same storage time have no significant difference ($p>0.01$)

from data in Table (7) it could be noticed that, the best fresh cakes were those of cakes containing 2.5% and 5% carob powder. 5% carob powder caused an improvement in all attributes compared with control cakes and cakes containing 7.5% carob powder. During storage, statistical analysis showed that significant changes ($p < 0.01$) in all attributes could be detected in control cakes and cakes containing 7.5% carob powder, while addition of 2.5% and 5% carob powder increased period of all attributes stability.

Crumb color of control cakes and cakes containing 2.5% carob powder after baking were significantly ($p<0.01$) higher than those of cakes containing 5% and 7.5% carob powder. Furthermore, during storage 21 days at ambient temperature, the crumb color of control cakes and cakes containing 7.5 % carob powder were significantly rejected at 21 days .

No significant differences between control cakes and those cakes containing 2.5%, 5% carob powder for brightness and texture after baking. At the end of storage period the brightness and texture of control cakes and cakes containing 7.5% carob powder were significantly ($p<0.01$) lower than those of cakes containing 2.5% and 5% carob powder.

Softness, aroma, and eating quality of cakes containing 2.5% and 5% carob during storage were significantly ($p<0.01$) higher than those of control cakes and cakes containing 7.5 % carob powder.

Carob fiber can have an excellent water - binding capacity and anti-caking properties, it can prolong a product's shelf-life. Other benefits were texture improvement, increased flow ability, and enhanced coloring, quality and freshness . (Linda, 2003).

CONCLUSION

From the overall results, it could be concluded that the addition of 2.5%, 5%, and 7.5% carob powder to cakes were act as antioxidant and antimicrobial for butter cakes during 21 days of storage.

The addition of 2.5% and 5% carob powder extend the shelf-life of cakes by reducing the incidence of staleness. In addition the cake quality characteristics were more acceptable than the control. The fiber-rich cakes obtained were also considered acceptable by the sensory panel. Carob fiber was the product with the most promising potential in the development of fiber-rich cakes in order to increase the daily fiber intake.

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مسحوق الخروب كمادة مضادة للميكروبات والأكسدة وتأثيره على خواص جودة الكيك

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تم دراسة تأثير مسحوق الخروب كمادة مضادة لنموالميكروبات وكذلك فى تحسين الخواص الريولوجيه لعجين الكيك . كما تم تصنيع كيك يحتوى على تركيزات مختلفة من مسحوق الخروب و(تم إستبدال ٢,٥، ٥، ٧,٥% من السكروز بمسحوق الخروب) ومقارنة ذلك بالكيك المصنع بدون مسحوق الخروب للمقارنة . وقد تم تحليل عينات الكيك المختلفة من حيث التركيب الكيماوى والخواص الطبيعية للكيك الطازج وأيضا تتبع خاصية البيات ودرجة ثبات دهن الكيك والمحتوى الميكروبى والخواص الحسية لعينات الكيك أثناء التخزين لمدة ٢١ يوم على درجة حرارة الغرفة وتحليل النتائج إحصائيا . وأوضحت النتائج المتحصل عليها أن استخدام ٤% من المستخلص المائي للخروب أدى إلى تثبيط نمو الخمائر والفطريات وكذلك *E . coli* ،*B . cereus* إضافة ٢,٥ و٥% من مسحوق الخروب أدى إلى زيادة لزوجة العجين مقارنة بالكنترول . وقد وجد أن نسبة الألياف الغذائية فى الكيك المصنع بنسب مختلفة من مسحوق الخروب كانت أعلى من المحتوى فى عينات الكنترول . إضافة مسحوق

الخروب أدى إلى زيادة الحجم النوعى للكيك كذلك سجل الكيك المحتوى على ٢,٥% و ٥% من مسحوق الخروب أحسن درجات اللون مقارنة بعينات الكنترول والعينة المحتوية على ٧,٥% من مسحوق الخروب . فى الأسبوع الثالث من التخزين كانت عينات الكيك المحتوية على ٥% و٧,٥% من مسحوق الخروب أعلى فى درجة الطزاجة مقارنة بالكنترول والكيك المحتوية على ٢,٥% خروب . وجد أن مسحوق الخروب أدى إلى تحسين ثبات دهن الكيك . بعد ٢١ يوم من تخزين عينات الكيك زاد العدد الكلى للبكتريا فى الكنترول إلى٢×١٠^{٣} بينما فى الكيك المحتوى على ٢,٥، ٥ و ٧,٥ % من مسحوق الخروب كان العدد الكلى للبكتريا ٢×١٠^{٢}، $١,٤ \times ١٠^{٢}$ و$٨\times$ ١٠ خلية / جرام على التوالى . إضافة مسحوق الخروب إلى الكيك أدى إلى خفض أعداد الخمائر والفطريات مقارنة بالكنترول وأدى إلى تحسين الخواص الحسية للكيك . ونستنتج من ذلك أن إضافة النسب المختلفة من الخروب إلى الكيك كانت لها تأثير مضاد للميكروبات ومضاد للأكسدة أثناء فترة التخزين . إضافة ٢,٥ و٥% من مسحوق الخروب أطال فترة حفظ الكيك وأدى إلى منع حدوث ظاهرة البيات بالإضافة إلى تحسين خصائص جودة الكيك مقارنة بالكنترول .