

Effect of date flesh fiber concentrate addition on bread texture

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Abstract

Composition of second-grade dates from the potential Tunisian cultivars "Deglet Nour" was similar to that of commercial dates. In fact, date flesh could present a value addition by extraction and use of date flesh fiber concentrate in bread formulation. Date flesh fiber concentrate (DFFC) of Deglet Nour variety was extracted and dried at 40 °C. This concentrate was added to wheat flour bread at 0.5%, 1%, 2% and 3% levels to increase the dietary fiber content. The effect of DFFC addition on the textural properties of bread during storage at 25 °C was investigated. In most cases, addition of DFFC did not affect significantly the water activity (a_w) values of crumb. During storage of breads, a significant reduction in a_w was observed in fortified breads with 1% and 3% levels of fibers. Besides, fresh bread (day-0) and stale bread (days-2) showed a significant increase in firmness of crumb whatever the addition level of fibers. Incorporation of DFFC in bread formulation could give an interesting value addition to date fleshes. This fact is of great economic interest owing to applications of DFFC in the food, pharmaceutical and medicinal industries.

Keywords: Date flesh fiber concentrate, bread, storage, firmness

1. Introduction

Date fleshes (*Phoenix dactylifera*. L) having hard texture could be easily recovered in technological or biological dates processing industries [12]. These by-products showed interesting chemical composition with high amount of sugar (79.93-88.02%), fiber (8.09-20.25%) and ash (1.73-2.59%) [14]. In addition, they could be regarded as an excellent source of DF with high technological functionality that could be used in food formulations [13, 14, 17].

The beneficial effects of dietary fiber (DF) for human health have been demonstrated in many studies [29] with recommendations for consumption ranging from 25 to 30 g [10]. The development of DF enriched food products is one of the best ways to increase the DF intake [21, 30, 32]. The main sources of fibrous materials, which can be incorporated into bakery products, particularly bread, are wheat bran, rice bran, sugar beet, date seed [4, 15, 19, 3].

Effect of addition of date flesh fiber concentrates (DFFC) on physico-chemical properties of dough and bread was studied

previously. The use of DFFC leads to improve dough rheological properties, increase dough yield and quality of fresh bread [14].

Bread staling is not a completely understood phenomenon. It refers to the changes that take place after baking other than spoilage by microorganisms. Bread staling results in decreased consumer acceptance of bakery products and in great economic losses [22].

The aim of the present study was to use different levels of DFFC and examine their effects on water activity and texture of the baked end-product during storage at 25 °C for 24h and 48h.

2. Materials and Methods

Commercial blend of wheat flour was purchased from State Milling Factory (Belgium). DFFC of Deglet Nour variety extracted as described in a previous work [14] and dried at 40 °C was used to make enriched fiber bread. Commercial compressed yeast was used for bread making. Salt was purchased locally. The emulsifier (mono and diacetyl tartaric acid esters

of mono and diglycerides of fatty acids (E472e), refined rapeseed oil, calcium carbonate (E170), ascorbic acid (E300) and enzymes (contain

wheat) was purchased from Puratos (Groot-Bijgaarden, Belgium). Properties of wheat flour and DFFC are given in Table 1 [14].

Table 1. Properties of wheat flour and DFFC^a

Properties	Wheat flour	DFFC
Moisture (%)	14.18 ± 0.03	10.47 ± 0.07
Protein (%)	12.61 ± 0.01	8.35 ± 0.08
Ash (%)	0.61 ± 0.01	3.60 ± 0.01
Fat (%)	-	0.87 ± 0.06
Total dietary fiber (%)	-	89.85 ± 0.16
Wet gluten (%)	38.40 ± 0.06	-
Gluten index (%)	99.85 ± 0.15	-
Sedimentation value (ml)	53.02 ± 0.58	-
Falling number (s)	282.50 ± 5.50	-

Results are expressed as mean values of two determinations ± SD; ^a Protein, ash, fat, total dietary fiber contents are reported at dry basis; Nitrogen factor 5.7 for wheat flour and 6.25 for fiber; DFFC: Date flesh fiber concentrate.

Moisture, ash and protein were determined following standard AOAC methods [8]. Fat content was determined according to the AFNOR norm NF V 03-713 [5]. Total dietary fiber content was determined according to the AOAC method 991.43 [8]. Wet gluten and gluten index were determined by using the “glutomatic” method [27]. Falling number and sedimentation value were determined by using AACC method 56-81B [2] and method 56-60 [3].

2.1. Bread Making Procedure

Basic dough formula on 250 g flour basis consisted of compressed yeast (2.5 g), emulsifier (7.5 g), salt (3.75 g), the amount of water required to reach 500 Brabender unit of consistency by the farinograph. DFFC was added in control dough formula at 0.5%, 1%, 2% and 3% levels in our previous work [14]. Breads (control, 0.5%, 1%, 2% and 3% levels) were prepared by mixing dough constituents and water with a farinograph. After mixing, doughs were fermented at room temperature for 10 min and then dough pieces (40 g) were divided, rolled and fermented for 30 min and finally were hand-moulded and sheeted. Doughs were proofed for 65 min at 30 °C and 95% relative humidity up to optimum volume increase, and baked at 230 °C for 15 min. For the aging studies, full baked breads were packed and stored at 25 °C for 24h and 48h.

2.2. Water Activity Measurement

For water activity (a_w), each loaf of bread was manually chopped into small pieces, poured into a conical flask. Water activity (a_w) was measured at 22 ± 1 °C using a Novasina Aw Sprint TH-500 apparatus (Novasina, Swiss).

2.3. Measurement of Bread Texture

Crumb firmness was measured using a Texture Analyzer (TA-XT2i, Stable Micro Systems, Survey, UK) at 2 hours, 24 hours and 48 hours to evaluate potential shelf life of the breads. Bread crumb firmness during storage was determined as maximum compression force according to AACC modified method 74-09 into a “Hold Until Time” test [1]. Two slices of bread were stacked and compressed with a 2.5 cm diameter cylindrical probe using the same speed as firmness to 50% strain, held for 60 s and then removed. The elastic recovery or springiness values were determined as a ratio of constant force during time holding to peak force before time holding. The bread crust hardness during storage was measured as maximum compression force following the AACC method 74-09 into a “Return To Start” test by using the Texture Analyzer (TA-XT2i). To be done, the analysis of texture was carried out with a cylindrical stem 8 mm in diameter. This probe penetrates of 10 mm in the center of the crust, before turning over to its starting point.

2.4. Statistical Analysis

All analytical values were determined using two independent determinations. Values of different parameters were expressed as the mean \pm standard deviation ($\bar{x} \pm SD$). The experimental data was analyzed statistically by analysis of variance using the SPSS 13.0 General Linear Model procedure. The calculated mean values were compared using Duncan's multiple range test with significance defined at $p < 0.05$.

3. Results and Discussion

3.1. Water Activity of Crumbs Containing Date Flesh Fiber Concentrate

Water activities of fresh crumbs (day-0) and stale crumbs (day-1) and (day-2) at different levels of DFFC are given in Table 2. The water activity of crumb containing different levels of fiber decreased during storage because of moisture loss. In fact, moisture changes contribute to staling through evaporation and water redistribution [7].

Table 2. Effect of DFFC on water activity (a_w) of crumb during storage

	Level of fiber added (%)				
	0	0.5	1	2	3
a_{w0} (0-day)	0.981 \pm 0.01 ^{aA}	0.974 \pm 0.00 ^{aA}	0.972 \pm 0.01 ^{aB}	0.972 \pm 0.00 ^{aA}	0.972 \pm 0.01 ^{aB}
a_{w1} (1-day)	0.937 \pm 0.01 ^{aA}	0.942 \pm 0.01 ^{aA}	0.941 \pm 0.01 ^{aAB}	0.940 \pm 0.01 ^{aA}	0.939 \pm 0.02 ^{aB}
a_{w2} (2-day)	0.883 \pm 0.07 ^{aA}	0.915 \pm 0.02 ^{aA}	0.886 \pm 0.02 ^{aA}	0.910 \pm 0.03 ^{aA}	0.842 \pm 0.01 ^{aA}

Results are expressed as mean values of two determinations \pm SD; DFFC: Date flesh fiber concentrate; Means in row with different small letters are significantly different ($p < 0.05$) between fiber levels for the same storage day; Means in column with different capital letters are significantly different ($p < 0.05$) between storage days for the same fiber level.

The water activity values of crumb at all levels of fiber added varied in the range of 0.981-0.883, 0.974-0.915, 0.972-0.886, 0.972-0.910 and 0.972-0.842 at day-0 and day-2 of storage, respectively. In most cases, the addition of DFFC at different levels did not affect the water activities values. These results were similar to those found by Lazaridou *et al.* [24]. In contrast, Rosell *et al.* [28] reported an increase of water activity due to the higher water holding capacity of the hydrocolloids. The water activity of fresh crumbs (day-0) was significantly higher ($p < 0.05$) than that of stale crumbs (day-2) particularly at 3% of fiber added (Table 2). This can be attributed to water evaporation during storage at 25°C. Czuchajowska *et al.* [16] reported that water activity of crumbs became larger when dough was kneaded with more water. Therefore, the difference of water activity

would be due to the differences of added water or remaining water in the crumbs [24].

3.2. Crust and Crumb Texture

The effects of DFFC supplementation on bread texture during storage are shown in Table 3 and Table 4. For the breads enriched with DFFC, the hardness of fresh crust (day-0) is a function of the rate of addition (Table 3). Breads showed a significant ($p < 0.05$) increase in hardness with addition of fiber. Indeed, the hardness of crust passes from 18.28 N to 35.32 N respectively for the control and the bread containing DFFC at 3% rate. The initial hardness of fresh crust was relatively high followed by a decrease of crust hardness at day-1; the crust was turned over in its hard state at day-2.

Table 3. Effect of DFFC on crust hardness during storage

Level of fiber added (%)	Hardness (0-day) (N)	Hardness (1-day) (N)	Hardness (2-day) (N)
0	18.28 \pm 1.98 ^{aA}	16.19 \pm 1.41 ^{bA}	18.55 \pm 1.24 ^{aA}
0.5	19.08 \pm 1.71 ^{aB}	11.15 \pm 1.31 ^{aA}	19.10 \pm 1.80 ^{aB}
1	28.11 \pm 0.50 ^{bB}	6.03 \pm 1.31 ^{aA}	36.73 \pm 1.28 ^{cC}
2	28.20 \pm 0.88 ^{bC}	7.14 \pm 1.32 ^{aA}	18.60 \pm 0.35 ^{aB}
3	35.32 \pm 0.42 ^{cC}	7.92 \pm 1.39 ^{aA}	27.84 \pm 0.30 ^{bB}

Results are expressed as mean values of two determinations \pm SD; DFFC: Date flesh fiber concentrate; Means in column with different small letters are significantly different ($p < 0.05$) between fiber levels for the same storage day; Means in row with different capital letters are significantly different ($p < 0.05$) between storage days for the same fiber level.

The increase in the initial hardness indicates that the damage of the bread constituents produced during storage might produce some effects during the full baking or the posterior cooling that favour the hardening. The amylose recrystallization plays an important role in the initial bread hardness and in the first stages of aging, because the formation of amylose network brings about the bread hardening [11].

The crumb firmness of breads enriched with DFFC is a function of the rate of supplementation (Table 4). Springiness was not

significantly different between DFFC supplemented breads and control. It was identical than the control bread whatever the incorporation rate (0.5-3%). No statistical difference between DFFC supplemented bread crumb firmness and the control. Regarding the staling, Breads showed a significant ($p < 0.05$) increase of crumb firmness at day-0 and day-2 of storage whatever the incorporation rate. However, no significant difference was observed in Springiness at 2 and 3% of fiber added during storage.

Table 4. Effect of DFFC on crumb freshness during storage

Parameters		Level of fiber added (%)				
		0	0.5	1	2	3
Springiness	0-day	0.45 ± 0.02 ^{abA}	0.38 ± 0.03 ^{aA}	0.46 ± 0.04 ^{abA}	0.42 ± 0.02 ^{abA}	0.49 ± 0.01 ^{bA}
	1-day	0.28 ± 0.07 ^{aAB}	0.34 ± 0.02 ^{aAB}	0.26 ± 0.02 ^{aAB}	0.20 ± 0.04 ^{aA}	0.29 ± 0.02 ^{aA}
	2-day	0.24 ± 0.02 ^{aB}	0.22 ± 0.04 ^{aB}	0.23 ± 0.02 ^{aB}	0.18 ± 0.03 ^{aA}	0.22 ± 0.04 ^{aA}
Freshness index	0-day	2.21 ± 0.07 ^{aA}	2.67 ± 0.23 ^{aA}	2.17 ± 0.17 ^{aA}	2.61 ± 0.51 ^{aA}	2.06 ± 0.04 ^{aA}
	1-day	3.66 ± 0.87 ^{aA}	2.92 ± 0.18 ^{aA}	3.95 ± 0.33 ^{aB}	4.62 ± 0.65 ^{aA}	3.52 ± 0.29 ^{aAB}
	2-day	4.23 ± 0.39 ^{aA}	4.80 ± 0.92 ^{aA}	4.35 ± 0.28 ^{aB}	5.56 ± 0.88 ^{aA}	5.07 ± 0.76 ^{aB}
Firmness (N)	0-day	0.73 ± 0.08 ^{aA}	0.71 ± 0.04 ^{aA}	0.54 ± 0.11 ^{aA}	0.61 ± 0.07 ^{aA}	0.77 ± 0.07 ^{aA}
	1-day	2.00 ± 0.35 ^{aAB}	1.47 ± 0.05 ^{aA}	1.67 ± 0.24 ^{aAB}	1.59 ± 0.13 ^{aA}	2.07 ± 0.48 ^{aA}
	2-day	3.98 ± 0.73 ^{aB}	3.89 ± 0.47 ^{aB}	3.40 ± 0.81 ^{aB}	4.63 ± 0.78 ^{aB}	5.68 ± 0.92 ^{aB}

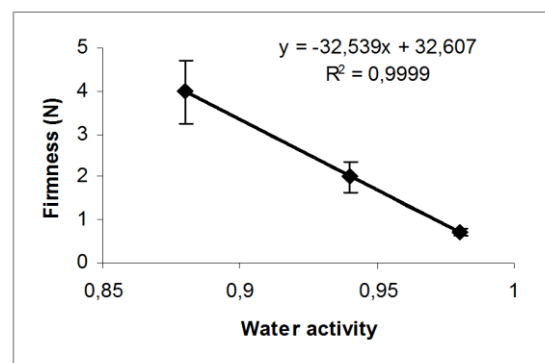
Results are expressed as mean values of two determinations ± SD; DFFC: Date flesh fiber concentrate; Means in row with different small letters are significantly different ($p < 0.05$) between fiber levels for the same storage day; Means in column with different capital letters are significantly different ($p < 0.05$) between storage days for the same fiber level.

The rapid increase of the crumb firmness can be attributed to the amylopectin recrystallization, [23]. The formation of complexes between starch and proteins, [25] the water redistribution among the bread constituents [22], and other phenomena that easily occur in this baked product during storage. The staling rate of the breads was not significantly decreased with storage time except the supplemented bread with 1 and 3% of fiber. Although, there are many papers on the retardation of retrogradation of starch and staling of bread induced by α -amylase retrogradation [6, 18, 20, 26].

3.3. Relationship Between Firmness and Water Activity

Fig.1 shows a negative correlation between firmness and water activity. Breads supplemented with DFFC exhibited the greatest increase of firmness, which is consistent with the large decrease of water activity values observed for these formulations during storage. Similarly,

Lazaridou *et al.* [24] examined the relationship between firmness and water activity of breads supplemented with xanthan.



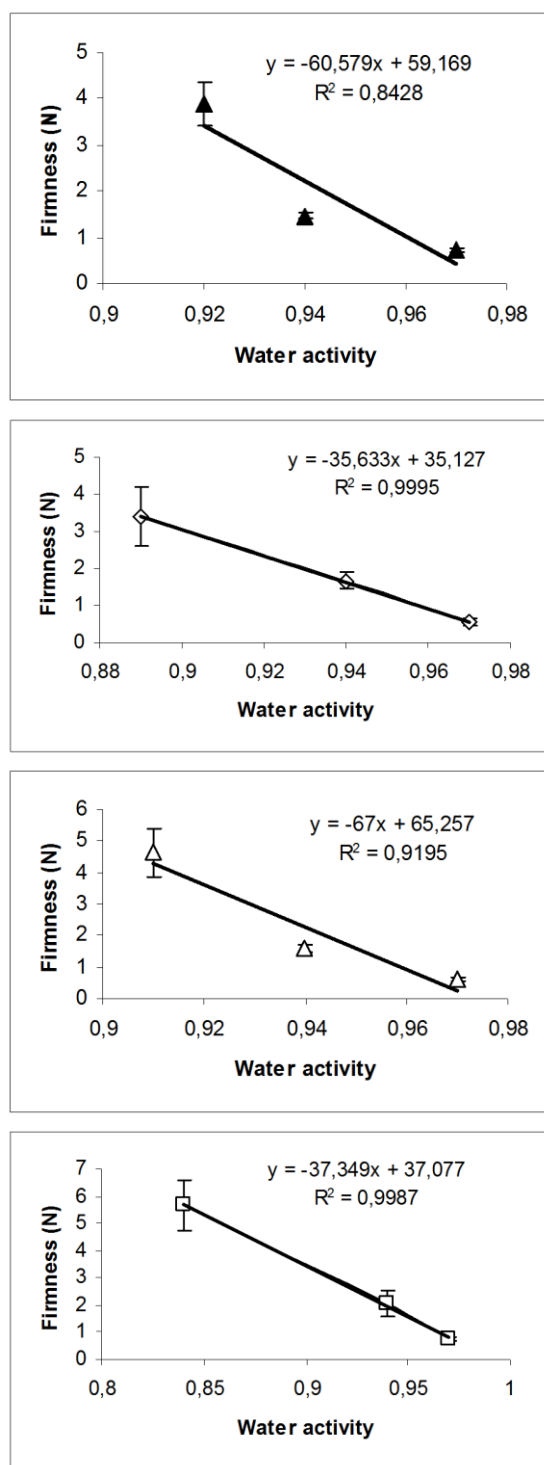


Figure 1. Relationship between firmness and water activity of breads containing different levels of DFFC. DFFC: Date flesh fiber concentrate, control \blacklozenge , 0.5% fiber \blacktriangle , 1% fiber \diamond , 2% fiber \triangle , 3% fiber \square

On the other hand, the inverse relationship between firmness and moisture content was previously studied [22]. Bread firmness is caused mainly by the formation of cross-links between partially solubilized starch and gluten proteins. In bread, water acts as a plasticizer. When moisture decreases, it accelerates the formation of cross-links between starch and protein and, thus, the bread firms faster [22].

4. Conclusions

This work demonstrated that by-products from date fleshes could be an excellent source of fiber. Extraction and addition of DFFC in bread formulation could give an interesting value addition to date fleshes. Results showed a significant decrease of water activities of fresh crumbs (day-0) and stale crumbs (day-3) at 1% and 3% level of fiber. All breads exhibited significantly the highest increase of firmness (from day-0 to day-1) whatever the addition level. The staling rate was not significantly decreased (from day-0 to day-2), except the fortified bread with 1 and 3% of DFFC.

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6. Notation

a_w	water activity
DFFC	date flesh fiber concentrate