Effect of Sodium Hydroxide Concentration on Recovery and Functional Properties of β-Glucan Extracted from Two Barley Varieties

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ABSTRACT

Barley β-glucan is a functional ingredient which has numerous industrial, nutritional and health benefits. Its extraction process may affect the physiochemical and functional properties of extracted β-glucan. The present research aimed to study the effect of β-glucan extraction with sodium hydroxide at concentrations of (0.25, 0.50 and 0.75 M) from two barley varieties (*Hordeum vulgare* L.) namely Giza 128 (Egyptian variety) and Al-Ryehan (Libyan variety). The obtained results indicated that yield, content, recovery and functional properties of β-glucan in gum extracts increased significantly ($P \leq 0.05$) with increasing sodium hydroxide concentration. The highest yield, content and recovery of β-glucan in gum extracts were obtained with 0.75 M for both varieties. Whippability, foam stability, stabilizing emulsion capacity and water binding capacity of β-glucan gums extracted with 0.75 M were the highest for both varieties. Giza 128 variety showed higher content, recovery (33.96% and 95.36%, respectively) and functional properties of β-glucan in gum extracts. Also the results suggested that barley with two rows was the best in the extraction compared with six rows. Overall barley β-glucan shows great potential as a thickener or stabilizer in food application.

Keywords: Barley, β-glucan, extraction, yield, recovery, whippability, emulsion stability, water binding capacity

INTRODUCTION

Barley (*Hordeum vulgare* L.) is one of the seven internationally grown cereal grains, currently ranking fourth in world production behind maize, wheat, and rice and ahead of sorghum, oats, and rye (Yalçin *et al.*, 2007; Griffey *et al.*, 2010). Starch, dietary fiber (DF) and protein are the main components of barley grain (Åman and Newman, 1986). Barley grains, like most other cereal grains, contain carbohydrate (starch and non-starch polysaccharides, oligosaccarides and sugars), protein, lipids, mineral, vitamins and other minor components. The chemical composition of grain is dependent on many factors such as genotype and environmental conditions (Ragaee *et al.*, 2006; Izydorczyk and Dexter, 2008).

In recent years, the importance of barley grains as a nutraceutical ingredient has increased because of their high contents

of soluble fiber, especially as a rich source of β-glucan. Because of its nutritional and chemical properties in particular a high dietary fiber content and high proportion of soluble viscous dietary fiber component, barley is considered the most suitable grain in human diet (Ahmad *et al.*, 2009). β-Glucans are non-starchy polysaccharides composed of (1→3),(1→4) mixed linked glucose units. (Irakli *et al.*, 2004).

In particular, much attention has focused on β-glucan because of its physiological effectiveness in lowering cholesterols and maintaining cardiovascular health (Newman *et al.*, 1989), controlling blood glucose levels for diabetes management (Pins and Kaur, 2006), anti-cancer activities and reducing the risk of colon cancer (Wood, 2007), promotion of the growth of beneficial gut microflora (i.e. as a prebiotic) (Su *et al.*, 2007), immune stimulation effects (Angeli *et al.*, 2009) and the reduction of risk factors for degenerative diseases, such as obesity, hyperlipidaemia, and hypertension (Brennan and Cleary, 2005). Thus, the industrial demand for this natural cereal-based compound is fast growing and has a great potential in future foods.

The techniques to concentrate β-glucan include dry milling and sieving or air classification and wet techniques such as aqueous/aqueous-alkali and alcohol based enzymatic techniques (Vasanthan and Temelli, 2008).

Several different wet methods have been reported in the literature for extracting β-glucan from oat and barley: enzymatic, alkaline, or water extractions with varying temperatures and incubation times. Sodium hydroxide extraction led to a nearly total extraction of β-glucan (Palmer and MacKenzie, 1986; Bhatty, 1993). Results of these studies revealed that temperature and pH have significant effect on extraction and functional properties of β-glucan (Ahmad *et al.*, 2010).

β-Glucan can offer many nutritional and rheological advantages to food products, the food industry always shows a keen interest in physiochemical and functional properties of novel nutraceutical compounds, as this will help in the choice of compound with particular characteristics for a specific food product. Extraction conditions may affect the physiochemical and functional properties of extracted β-glucan (Ahmad *et al.*, 2010). Therefore, the aim of this study was to assess the best concentration of sodium hydroxide to recover the highest amount β-glucan from two barley varieties and to

evaluate its effect on functional properties of extracted β-glucan as potential food applications.

MATERIALS AND METHODS

Materials:

Two barley varieties (*Hordeum vulgare* L.) namely: Giza 128 (two rows variety) was obtained from the Agricultural Research Center (Egypt) grown in (2008\2009) and Al-Ryehan variety (six rows variety) was obtained from the Agricultural Research Center and Animal (Libya) grown in (2009\2010), were used in this study.

Methods:

Barley grains were ground in mill to pass through 1-mm sieve with sample mill (Model: WK 5021804, Culatti Typ MFC. Germany).

Chemical Analysis

Whole barley flour was analyzed for proximate composition according to approved methods (AACC, 2000): crude fiber, protein, lipids, ash and moisture. Carbohydrates content by difference.

β-Glucan content

The method for the determination of β-Glucan content (in barley flour and freeze-dried preparated β-glucan extracts) was developed by McCleary and Glennie-Holmes (1985) using Megazyme kits (Megazyme International Ireland Ltd.,Wicklow, Ireland). Highly purified enzymes were employed. Triplicate samples (0.5 g of flour and/or < 0.1 g of β-glucan extracts) were weighed and β-D-glucan depolymerized with purified (1→3),(1→4)-β-D-glucanase to oligosaccharides and then hydrolyzed to glucose with specific purified β-glucosidase. Glucose was determined by glucose oxidase/peroxidase solution as D-glucose and the absorbance was measure at 510 nm by a spectrophotometer (Model: Thermo scientific, England). β-Glucan content was calculated using the glucose quantity found in the Eq.

$$\beta\text{-Glucan (\% w/w)} = \Delta A \times \frac{F}{W} \times 27$$

Where: ΔA = absorbance after β-D-glucosidase of treatment – blank absorbance, W is dry weight of the sample analysed in mg, and F, a factor for conversion of absorbance values to μg of glucose.

$$F = \frac{100\ (\mu g\ \text{of D} - \text{glucose})}{\text{absorbance of } 100\ \mu g\ \text{of D} - \text{glucose}}$$

Extraction of β-glucan

β-Glucan was extracted from whole barley flour using the methods of Carr *et al.* (1990) and Bhatty (1993 and 1995) using sodium hydroxide solution at concentration of 0.25, 0.50 and 0.75 M. These concentrations were chosen depending on preliminary extraction experiment and according to previous studies. The ratio of flour to solvent was 1:50 (50g flour: 2500 ml sodium hydroxide solution). The extraction time was 18 hr at room temperature with continuous stirring using a shaker (Model: Edmund Bühler SM-30, Germany). At the end of extraction time, the mixture was centrifuged (Model: SORVALL RC 6 plus, Thermo Electron Corporation, Germany) for 15 min at 6,000 × g at 4 °C to remove solids. The supernatant was adjusted to pH 4.5 with 2 M HCl and centrifuged again (15 min at 6,000 × g at 4 °C) to separate precipitated proteins, which were discarded. β-Glucan was precipitated by addition of an equal volume of ethanol (adding absolute ethanol to supernatant in order to increase the final ethanol concentration to 50% v/v) to the supernatant slowly with stirring. The precipitate was recovered by centrifugation (15 min at 6,000 × g) after allowing it to settle over-night at 4 °C. The rubbery pellet was re-suspended in water; washed twice with 50% ethanol, centrifuged (15 min at 6,000 × g at 4 °C), homogenized in water, and then freeze-dried at -90 °C for a few days in a freez-dryer (Model: Gamma-16 LSC, Christ, Germany). The dry extracts were ground in mill to pass through 1-mm sieve, and then the extracted gum was stored in sealed containers.

Physical functional properties of β-glucan extracts

Whippability and foam stability of β-glucan extracts

Whippability and foam stability of β-glucan extracts were measured according to Temelli (1997) by dispersing ca. 2.5 g β-glucan extract in 100 ml water, whipping for 2 min using a hand-held food mixer at high speed in a stainless steel bowl with straight sides. Foam was transferred from the bowl by pouring gently down the walls of an inclined cylinder not to disturb the foam and to ensure that no air pockets were trapped in the cylinder and allowed to set at room temperature (≈ 21 °C), volumes were recorded before and after whipping. Volume increase percentage (which serves as index of foaming capacity or whippability) was calculated according to the following equation:

$$\text{Volume increase (\%)} = \frac{V2 - V1}{V1} \times 100$$

Where: V1 = volume of solution before mixing and V2 = volume of solution after mixing.

To determine the foaming stability (FS), the volume of foam that remained after staying at (≈ 21 °C), and calculating the time required to decline foam to the half, according to Burkus and Temelli (2000).

Emulsion stabilizing capacity of β-glucan extracts

Emulsion stabilizing capacity of β-glucan extracts was determined using the modified procedure of Smiles *et al.* (1989). β-Glucan extract (0.4 g) was dispersed in 40 ml water. Corn oil (60 ml) was added slowly and the mixture was blended for 2 min using a homogenizer (25,000 rpm) (Model: Ultra-TURRAX T8 IKA-WERKE, Germany) at room temperature (≈ 21 °C). Aliquots of emulsion were transferred into 50 ml graduated tubes and centrifuged for 15 min at 2,700×g. Volumes of separated phases were recorded. Emulsion stability was reported as the volume of emulsion remaining un-separated after centrifugation as a percentage of original volume.

Water binding capacity of β-glucan extracts

The water binding capacity of samples was measured using the method described by Ahmad *et al.* (2010). Distilled water (20 ml) was added into a centrifuge tube containing 200 mg β-glucan extract, after which it was placed in a shaker (Model: Edmund Bühler SM-30, Germany) at 25 °C for 3 hr, the tubes were centrifuged at 14,000×g for 30 min at 25 °C (Model: SORVALL RC 6 plus, Thermo Electron Corporation, Germany). The supernatant (unbound water) was discarded, and the amount of water held in the hydrated sample was determined by heating the pre-weighed pellet in a hot air oven for 2 hr at 120 °C. The water binding capacity of each sample was expressed as the weight of water hold by 1.0 g of β-glucan extracts.

Statistical analysis

All analyses were carried out in triplicate and the data were reported as means ± standard error. Data of proximate composition, β-glucan content and extract were analyzed by a one-way analysis of variance (ANOVA) ($P \leq 0.05$). Duncan's test was used to establish the differences among the mean values at the 0.05 significance level. These statistical analyses were carried out using Microsoft Excel 2007.

RESULTS AND DISCUSSION

Chemical composition of barley varieties

The proximate chemical composition of two barley varieties is shown in Table (1). Data revealed that there were significant differences ($P \leq 0.05$) in chemical composition in barley varieties. Results also show that Giza 128 variety contained 3.55, 11.51, 20.68, 60.94 and 3.32% crude fat, crude protein, crude fiber, carbohydrate and ash, respectively. Meanwhile, AL-Ryhan variety contained 1.49, 11.49, 14.15, 69.98 and 2.88%, respectively. The main components of the barley samples were carbohydrate, crud fiber and protein. These three constituents together make up more than 90% of the dry matter. β-Glucan content was 4.08% in AL-Ryhan and 4.11%, in Giza 128 as shown in Table (2). Data also revealed that barley flour is a good source of dietary fiber which may be used as beneficial functional ingredient in various food products. These results are in agreement with those of Baik and Ullrich (2008). They found that whole barley grain consisted of about 65-68% starch, 10-17% protein, 2-3% free lipids and 1.5-2.5% minerals. Total dietary fiber ranged from 11 to 34% and soluble dietary fiber from 3 to 20% (Fastnaught, 2001). Helm and Francisco (2004) also concluded that Brazilian barley varieties showed crude protein content from 11.55 to 15.92%, crude fat 2.91 to 4.00%, ash 1.51 to 2.27% and crude fiber 5.95 to 7.12%. The chemical composition of barley may be affected by both genetic and environmental factors Oscarsson *et al.* (1997). It has been reported that barley β-glucan contents have ranged from less than 2% to more than 10% (Zhang *et al.*, 2002; Hang *et al.*, 2007and Izydorczyk and Dexter, 2008).

Yield, content and recovery of β-glucan in gum extracts

Effect of different NaOH concentrations on yield (wt. of gum/100 g flour) content and recovery [To evaluate the efficiency of extraction at different conditions of extraction (wt. of β-glucan in gum extract /wt. of β-glucan in 100 g flour)] of β-glucan in gum extracts are presented in Table (3) for Giza 128 and AL-Ryhan. The obtained results indicated significant difference ($P \leq 0.05$) in yield, content and recovery of β-glucan in gum extracts at different concentrations for both varieties with observed significant positive effect when increasing sodium hydroxide concentration.

There was no significant differences ($P \leq 0.05$) in yield at sodium hydroxide concentration 0.25 and 0.50 M, but differed significantly at 0.75 M for both varieties. Yield of β-glucan gum extracts ranged from 8.49-12.17%, the highest yield of β-glucan was at 0.75 M. The observed increase in yield at highest sodium hydroxide concentration may be due to the swelling starch granules which makes them more soluble at high pH (Adebowale *et al.*, 2005), and also the increased protein solubility at high sodium hydroxide concentration (Adebowale *et al.*, 2002).

Also, there was no significant difference ($P \leq 0.05$) in content of β-glucan at sodium hydroxide concentration 0.50 and 0.75 M, for AL-Ryhan differed significantly at 0.25 M, while Giza 128 differed significantly at 0.75 M only. β-Glucan content in gum extracts ranged from 24.98-33.96% for tested barley varieties, the highest content of β-glucan was at 0.75 M. However, if a harsh extraction procedure with 0.25-1 M NaOH is performed, solubilization of a substantial amount of starch can result in a lower purity gum, and preferably treated with amylolytic and protease enzymes for increasing the purity (Bhatty, 1995).

Significant differences ($P \leq 0.05$) were found in recovery at all concentrations of sodium hydroxide. β-Glucan recovery of gum extracts ranged from 64.02-95.36%, and the highest recovery of β-glucan (95.36%) obtained with 0.75 M for Giza 128. There have been several studies dealing with the extraction of β-glucan from oat and barley, and much variability in the results was evident due to differences in both starting material and extraction techniques. In this study significant positive effect in recovery was observed with increasing of sodium hydroxide concentration, and these results were in agreement with Bhatty (1995) who extracted β-glucan with 0.25-1 M NaOH at room temperature and found that the efficiency of extraction increased with increasing sodium hydroxide concentration. Thus, sodium hydroxide concentrations greater than 0.5 M extracted almost all of the β-glucan from barley under laboratory conditions, although 0.75 M was equally effective. Thus, results in the present research conclude that sodium hydroxide proved to be an excellent solvent for β-glucan extraction and recovery.

Functional properties of β-glucan extracts

Whippability and foaming stability of β-glucan extracts

Whippability of β-glucan resulted in the formation of foams, these foams was attributed to the creation of stable network. Whippability of β-glucan gum appeared to be affected by the extraction technique. Whippability is important in many food-processing operations such as in cake formation (Ahmad *et al.*, 2010).

There was no significant difference ($P \leq 0.05$) in whippability and stability of foams of β-glucan extracts with sodium hydroxide solution of different concentration used in this study for AL-Ryhan variety, but for Giza 128 significant differences were found between both concentrations of 0.25 and 0.50 M on one hand and 0.75 M on the other. Maximum whippability was obtained (201%) at 0.75 M for Giza 128, also a positive relationship between the content of β-glucan in extracts and whippability was found. Maximum time to 50% drainage of foams formed by β-glucan concentrates was ≈ 170 min for Giza 128 Figures (1 and 2). Giza 128 variety reached the highest functional properties of β-glucan in gum extracts, also β-glucan extracted from Giza 128 showed higher stability of foams than AL-Ryhan variety. Highest whippability with the 0.75 M could be due to the highest amount of β-glucan, in addition, to relatively highest protein contents that trapped more air thus developing more foam. In addition, sodium hydroxide extracted more pentosans than other solvents. These non-starch polysaccharides enhance the viscometric properties of β-glucan and thus, whippability and stability of foams of β-glucan, a desirable feature in food applications (Bhatty, 1993). Ahmad *et al.*, (2009) found that different extraction methods had a significant ($P < 0.05$) effect on foaming capacity of β-glucan. The highest foaming capacity was observed when the samples were extracted by hot water extraction procedure followed by alkali (1 M NaOH), and extraction methods exerted non-significant ($P < 0.05$) effect on foaming stability of β-d-glucan gum.

Emulsion stabilizing capacity of β-glucan extracts

The emulsion stabilizing capacity of β-glucan extracts are shown in Figure (3). There were significant differences ($P \leq 0.05$) in emulsion stabilizing capacity of β-glucan extraction by sodium hydroxide, emulsion stabilizing ranged from 51.67-80.42%, and the highest stability was obtained at 0.75 M concentration followed by

0.50 M and then 0.25 M for both varieties. Also, a positive relationship was found between the content of β-glucan in extracts and emulsion stabilizing capacity. According to Burkus and Temelli (2000) found that in emulsion (50% oil/water), droplet size decreased several fold when prepared with barley β-glucan gum and phase separation was substantially decreased. Previous research (Temelli, 1997) indicated that β-glucan shows a potential as a foam and emulsion stabilizer, though other components present in β-glucan concentrates, possibly starch, pentosans, or proteins, likely contribute to the stability of these systems as well.

In general, in the case of food emulsion systems, polysaccharides are very often used to improve the emulsion stability and textural properties. However, very limited information is available in the literature regarding the emulsion stabilizing capabilities of β-glucans, particularly in the presence of another stabilizer such as whey protein concentrate and egg yolk, most have focused on cereal β-glucans.

Water binding capacity of β-glucan extracts

Water binding capacity (WBC) is defined as the amount of water retained by 1 g of dry fibers under specified conditions of temperature, soaking time, and duration and speed of centrifugation. However, a portion of the soluble fibers is lost during measurement, affecting WBC (Fleury and Lahaye, 1991). β-Glucan has high water binding capacity due to an abundance of hydroxyl groups within its structure.

Data in Table (4) showed the water binding capacity (WBC) of β-glucan extracts. The WBC of a fiber measures the amount of water retained by the fiber after being subjected to stress such as centrifugation. These hydration properties of barley β-glucan are important in many food applications and have an impact on shelf life of food product. The results obtained indicated significant differences ($P \leq 0.05$) in WBC of β-glucan extracts for both varieties.

The WBC of β-glucan extract from sodium hydroxide ranged between 6.02 and 8.61 gg^{-1} for extracts. β-Glucan extracted with 0.75 M NaOH concentration showed highest WBC for both variety followed by NaOH concentration 0.50 M, which is statistically comparable ($P \leq 0.05$), a lower value of WBC was observed in 0.25 M NaOH concentration. Very limited studies examined WBC of β-glucan, Ahmad *et al.* (2009) found that β-Glucan extracted by hot

water treatment had highest value of WBC (3.79 gg^{-1} dw) followed by alkali (1 M NaOH) and acid extracted β-glucan, a slightly lower value of WBC was observed in samples that were extracted enzymatically. The values obtained in their study for WBC are comparable to that of some other dietary fibers derived from processing of byproducts [sugar beet fiber 4.56 gg^{-1}, wheat bran 2.6 gg^{-1}, corn bran 2.5 gg^{-1} and soybean bran 2.4 gg^{-1}]. In another study Ahmad *et al.* (2010) found that water binding capacity (WBC) of the β-d-glucan from oat ranged between 3.14 and 4.52 gg^{-1}. β-Glucan extracted by an acidic extraction procedure showed highest water binding capacity.

However, the reasons for the highest WBC of barley β-glucans in the present study could be due to relatively highest protein and starch contents in β-glucan extracts which had the ability to bind water. The high value of WBC for β-glucan in extracts suggests that this material could be used successfully as a functional ingredient to avoid syneresis problems in various food products such as jam, jellies, sauces and cheese (Ahmad *et al.*, 2009).

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Table (1): Proximate composition of two barley varieties* (%, dry weight basis)

Component (%)	variety	
	Giza 128	AL-Ryhan
Dry matter	88.17^{b}±0.03	91.50^{a}±0.06
Crud fat	3.55^{a} ±0.02	1.49^{b} ±0.02
Crud protein	11.51^{a}±0.03	11.49^{a}±0.02
Crude fiber	20.68^{a}±0.70	14.15^{b}±0.08
Carbohydrate	60.94^{b}±0.69	69.98^{a}±0.08
Ash	3.32^{a} ±0.02	2.88^{b} ±0.05

*Means within a raw with different letter are significantly different at ($P \leq 0.05$).

Total (2): β-Glucan content of two barley varieties* (%,dry weight basis)

Variety	β-Glucan (%)
Giza 128	$4.08^{a} \pm 0.06$
AL-Ryhan	$4.11^{a} \pm 0.06$

*Means with the different letter are significantly different at ($P \leq 0.05$).

Table (3): Effect of sodium hydroxide concentrations on yield, β-glucan content and recovery (%) of gum extracts from Giza 128 and AL-Ryhan varieties

variety	NaOH (Molar)	Yield [a]	β-Glucan [b]	Recovery [c]
Giza 128	0.25	$8.49^{b} \pm 0.44$	$26.16^{b} \pm 0.22$	$54.37^{c} \pm 2.45$
	0.50	$9.82^{b} \pm 0.21$	$27.94^{b} \pm 0.47$	$67.25^{b} \pm 1.21$
	0.75	$11.48^{a} \pm 0.33$	$33.96^{a} \pm 1.33$	$95.36^{a} \pm 1.24$
AL-Ryhan	0.25	$10.53^{b} \pm 0.14$	$24.98^{b} \pm 0.37$	$64.02^{c} \pm 1.55$
	0.50	$10.73^{b} \pm 0.17$	$27.65^{a} \pm 0.24$	$72.19^{b} \pm 1.78$
	0.75	$12.17^{a} \pm 0.13$	$28.33^{a} \pm 0.27$	$83.88^{a} \pm 1.16$

Means within a column in the same variety with different letter are significantly different at ($P \leq 0.05$).
[a] Yield = g gum extract/100 g barley flour (d.w.b).
[b] β-Glucan = g β-Glucan/100 g gum extract (dwb).
[c] Recovery = g β-Glucan in gum extract from g β-Glucan in 100 g barley flour (dwb).

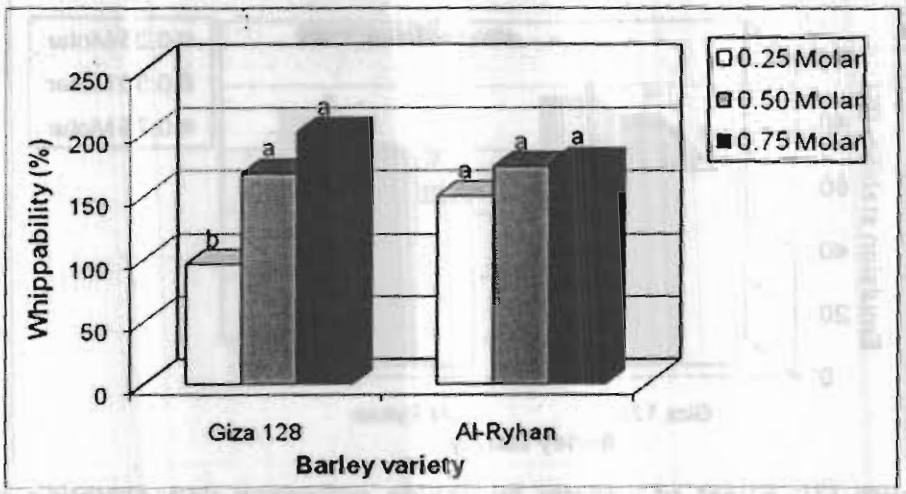

Figure (1): Effect of sodium hydroxide extraction concentration on whippability of β-glucan extracts from two barley varieties. Bars within variety with the different letter are significantly different (P ≤ 0.05).

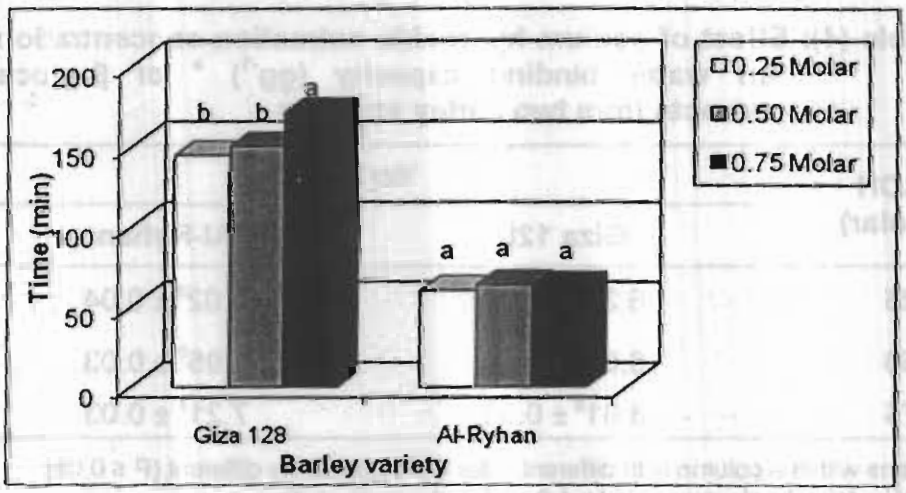

Figure (2): Effect of sodium hydroxide extraction concentration on the time to 50% drainage of foams formed by β-glucan extracts from two barley varieties. Bars within variety with the different letter are significantly different (P ≤ 0.05).

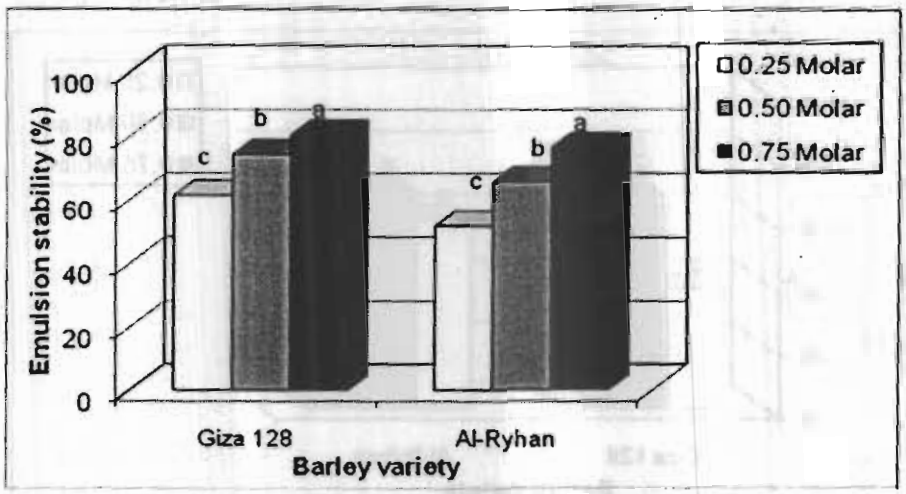

Figure (3): Effect of sodium hydroxide extraction concentration on stability of emulsions formed by β-glucan extracts from two barley varieties. Bars within variety with the different letter are significantly different (P ≤ 0.05).

Table (4): Effect of sodium hydroxide extraction concentrations on water binding capacity (gg^{-1}) [a] of β-glucan extracts from two barley varieties

NaOH (Molar)	Variety	
	Giza 128	Al-Ryhan
0.25	$6.35^{c} \pm 0.01$	$6.02^{c} \pm 0.04$
0.50	$6.85^{b} \pm 0.02$	$6.95^{b} \pm 0.03$
0.75	$8.61^{a} \pm 0.01$	$7.21^{a} \pm 0.03$

Means within a column with different letter are significantly different (P ≤ 0.05).
[a] gg^{-1} = Weight of water held by 1.0 g of β-glucan extracts.

الملخص العربي

تأثير هيدروكسيد الصوديوم على نسبة استخلاص البيتا جلوكان وخواصه الوظيفية في صنفين من الشعير

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بيتا جلوكان الشعير هو مكون وظيفي له العديد من الفوائد الصناعية والتغذوية والصحية، وإستخلاصه يحتاج إلى عناية وإهتمام لأن عملية الإستخلاص يمكن أن تؤثر في الخواص الطبيعية والوظيفية للبيتا جلوكان المستخلص. لذلك تهدف هذه الدراسة إلى تقييم تأثير عملية الإستخلاص بواسطة هيدروكسيد الصوديوم بتركيزات 0.25، 0.50 و0.75 مولر على صنفي شعير جيزة 128 (صنف شعير مصري) والريحان (صنف شعير ليبي) والتي تحتوي على 4.08% و4.11% بيتا جلوكان على التوالي، وتلت عملية االإستخلاص تقدير الخواص الوظيفية للبيتا جلوكان المستخلص. أوضحت النتائج المتحصل عليها زيادة معنوية ($P \leq 0.05$) في النسبة المئوية للناتج والمحتوى والإستخلاص والخواص الوظيفية للبيتا جلوكان في المستخلصات بزيادة تركيز هيدروكسيد الصوديوم، وتركيز 0.75 مولر أعطى أعلى ناتج ومحتوى وإستخلاص وخواص وظيفية للبيتا جلوكان لكلا الصنفين. وأظهرت النتائج أن القابلية للخفق (Whippability) وثبات الرغوة وثبات المستحلب والقدرة على ربط الماء لمستخلصات البيتا جلوكان بتركيز 0.75 مولر كان الأعلى في كلا الصنفين. وقد أعطى صنف الشعير جيزة 128 أعلى نسبة محتوى وإستخلاص (33.69% و95.36% على التوالي) وخواص وظيفية للبيتا جلوكان مقارنة بصنف الريحان. وأوضحت النتائج أن هيدروكسيد الصوديوم بتركيز 0.75 تركيز جزيئي كان الأفضل لإستخلاص البيتا جلوكان من الشعير، وصنف الشعير ذو الصفين أفضل استخداماً في الإستخلاص مقارنة بالشعير ذو الست صفوف. وعموماً فإن بيتا جلوكان الشعير له إمكانيه كبيرة في إستخدامه كمادة تعطي القوام أومثبت في التطبيقات الغذائية.