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Effect of Using Saline Water on Quality Changes of Some Seed Dry Sprouts and the biscuit taste

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ABSTRACT

Sprouting seeds is an effective process to improve diet quality. Furthermore, consumer's increasing demands for various bakery products represents an opportunity to use such sprouts flour from mixing wheat with legumes for preparing biscuits. Thus, this research studies the effect of saline water (2000 ppm) on the characteristics of fresh sprouting seeds and quality changes of dry seeds sprouted powder of wheat grains, chickpea, fenugreek, and faba bean. Seeds sprouted powder used crushing in preparing biscuits and chose the best mixing ratios of studied seeds. Results indicate the negative effect of salinity concentration of 2000 ppm on characteristics of fresh sprouting. Chickpea, fenugreek, wheat and faba bean which recorded the shortest radical length and the lowest sprouting percentage, while faba bean recorded lower data of water uptake under 2000 ppm. Salinity increased protein content, Nitrogen, Potassium, Chlorine, and sodium (%). Biscuits experiments' results showed that sprouted fenugreek flour recorded the lowest panel taste under all mixing ratios. While biscuit taste prepared from sprouted seeds flour by tap water was better than that of sprouted seeds flour by saline water.

Keywords: Wheat grains, legumes, Sprouting, Salinity, Biscuits.

INTRODUCTION

For Egypt's economy, wheat *(Triticum sativum* L.*)* is a crucial crop. Due to their good effects on health, whole grain food products have been promoted in study publications throughout the past few decades (Luthria *et al*., 2015; Basma *et al*., 2019). According to Maghsoudi (2008) and Ibrahim *et al.* (2017), it is Egypt's main grain crop and a somewhat salt-tolerant one. In many places of the world, legumes are one of the most abundant and affordable sources of protein for people to consume. Due to their high and high-quality protein content (22–35%), faba bean and chickpea have the most potential among them, whereas legumes have higher nutritional qualities (Saastamoinen *et al*., 2013). During the sprouting process, sprouts develop from seeds. Sprouts are excellent providers of protein, vitamins, and minerals. They also contain key elements that support good health, such as phytochemicals and enzyme-rich components found in cereals and legumes. The sprouts' nutrient concentration is still very high because they are eaten at the start of the growing phase. In addition to the phytochemical nutrients found in sprouts, vitamins, minerals, enzymes, and amino acids are crucial since

they are the most beneficial to human health (Ibrahim *et al*., 2017). The critical stage in a plant's life cycle is seed germination. The processes of germination include those that start with the dry seed absorbing water and culminate with the appearance of radicals (Copeland and McDonald, 2001 and Ali *et al*., 2019). Water uptake with a seed is three phases: the first phase is rapid initial intake; the second phase is a lull and the third phase is an increase of water uptake, but, only while sprouting taking place (Manz, 2005).

Salinity is an extensive problem in agriculture, as a major part of abiotic stresses in arid and semi-arid regions and having an impact on the global land area used for agriculture (Kumawat *et al*., 2017). Salinity decreases a plant's ability to absorb water, which inhibits plant growth and causes metabolic changes (Kader and Jutzi, 2002). A lot of research showed that the use of salt water in sprouting helped to produce healthy food with high nutritional value (Abd El-Azim *et al*., 2019 & Soliman, Basma *et al*., 2019). Recent research is focused on the production of dry sprout flour for use when needed with ease of circulation to produce types of baked goods (Ibrahim *et al*., 2017). Dried sprouts are used instead of fresh ones to increase the nutritional value of food products and avoid bacterial contamination (Koehler *et al*., 2007). Biscuits are a popular bakery product all over the world. They are high in calories, fat and carbohydrates, but low in vitamins, fiber, and minerals which make it unhealthy for daily consumption. Because of its better taste, acceptability in all age groups, its position as snacks and longer shelf life it is considered a good product for protein fortification and other nutritional improvement (Serrem *et al*., 2011). Furthermore the biscuit formulation can be easily modified to meet the nutritional needs of the target consumer (Ashaye, Olanipekun *et al*., 2015). Many researchers reported that supplementation of wheat flour and sprouted legumes (such as: soy bean, chickpea flour, germinated, faba bean and lentils) are greatly improve the quantity of nutritional protein in bakery products (Basman and Koksel, 2003; Ribotta *et al.,* 2005; Gômez *et al.,* 2008; Abd El Ghany, *et al.,* 2017 and Ibrahim, *et al.,* 2017).

Therefore, the aims of the research include Studying the effect of saline water (2000 ppm) on the characteristics of fresh sprouting seeds and quality changes of dry seeds sprouted powder of wheat grains, chickpea, fenugreek, and faba bean. It used crushing in preparing biscuits and choosing the best mixing ratios of the under study seeds.

MATERIALS AND METHODS

Two experiments were conducted in the seed sprouting laboratory, Horticulture Department, Faculty of Agriculture, Ain Shams University, Cairo, Egypt.

1. **Sprout Experiment.**

a. **Sprout Experiments with Saline Water (NaCl at 2000 ppm):** Three fabaceae crop species were selected, Chickpea *(Cicer arientium, L.)* Giza3 cultivar, Fenugreek *(Trigonella foenum graecum, L.)* Giza 2 cultivar, Faba bean *(Vicia faba, L.)* Giza716 cultivar and Wheat *(Triticum aestivum L.)* Masr1 cultivar. They were obtained from field crop institute, Agriculture Research Center of Giza and NaCl was obtained from El-Gomhoria Chemical Company, Cairo, Egypt. Sprouting was done using two levels of NaCl concentration (2000 ppm) and without NaCl (tap water control).

b. **Experimental design:** Complete Randomize Design, Factorial experiment in three replications using four experiments include four crop species. Each experiment consisted of 100 gm. seeds chickpea, fenugreek, wheat and faba bean in each replicate. Each crop of seed was divided into 2 groups (3 replicates in each group). Clean seeds to remove broken, damaged and off- colour grains of each replicate were placed and soaking in 200 ml tap water glass jar for 9hr soaking followed by 24hr sprouting in dark using the sprouting glass jar method as described by Abdallah, 2008.

c. **Sprout characters: Morphological characteristics of sprouted wheat, chickpea, fenugreek and faba bean:** Water uptake by weight (%), Seeds in each treatment jar were weighed before soaking (initial weight) and after 9hr seed soaking and after 24hr sprouting (final imbibition seed weight) **(**Baskin *et al*., 2006; Orozco-Segovia *et al*., 2007 and Silva *et al*., 2018). using the following equation: Water uptake by weight (%)

$$= \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \text{ x } 100$$

The percentage of sprouting was determined after 24hr sprouting in dark using the following equation:

$$\text{Sprouting percentage (\%)} = \frac{\text{Number of sprouted seeds}}{\text{Number of total seed}} \text{ x } 100$$

Ten sprouts were chosen randomly for measuring sprout radical length (mm).

Sprout fresh weight: sprouted seeds were measured by gram (g).

Sprout dry weight: sprouted seeds recorded by gram (g) after oven drying 60°C for 48 hr.

Chemical analysis of sprouted wheat, chickpea, fenugreek and faba bean flour:

Sprout samples for proximate analyses were oven dried at 60˚C for 48 hours for both tap water and NaCl solution according to (FAO Soil Bbulletin 1989).

The proximate analysis:

The crude protein was calculated by multiplying the total organic nitrogen by 6.25 calculated by the following equation:

Protein % = % N × 6.25

From the dried sample, Total nitrogen content (N %) was determined using Micro-kjeldahle method Vapodest 45s. While, Phosphorus (P %) was determined by colorimeter method (ammonium molybdate) using spectrophotometer Thermo, UV-VIS EVOLUTION300. Calcium (Ca %), Sodium (Na %), Potassium (K %), Magnesium (Mg ppm), Manganese (Mn ppm), Cupper (Cu ppm), Zinc (Zn ppm) and Iron (Fe ppm) were determined by atomic absorption spectrophotometry Thermo, ICE 3000 SERIES according to the method described by (Chapman and Pratt, 1982). While, Chlorine (Cl %) was analyzed by according to the method described in the (AOAC, 2012).

2. Biscuits Experiments.

a. **Preparation of sprouted wheat, chickpea, fenugreek and faba bean biscuits:** After one day glass jar sprouting methods the collected sprouts were sun-air-dried according to **(**Dzowela *et al*, 1995). Biscuits were produced using mixtures of dry seed sprouted flour, including (wheat, chickpeas, fenugreek, faba bean) using different mixing ratios with taking sensory readings on the taste compared with flour markets (wheat flour 72%) and whole wheat grains (by the shell) and the ingredients used in biscuits preparation were fresh milk; butter and baking powder were purchased from the local market.

b. **Biscuit formula and ingredients:** The recipe of the biscuit was as described by Adebowale *et al*. (2012) and Ibrahim *et al.* (2017) (modified). Biscuit dough was prepared according to the following formula: sugar (175g) and fat (325g) were creamed in a mixer with a flat beater at 60 revolutions per minute for 2 minutes. Fresh milk (125g) was added to the above cream and mixed for 5 minutes at 125 revolutions per minute to obtain a homogenous cream. Then, composite flour (500g) with baking

powder (10g) was added and mixed for 3 minutes at 60 rpm. Then biscuits dough was shaped using piping bag with special tip and baked in tray in oven at 180°C for 20 minutes.

c. **Sensory analysis:** Sensory evaluation of biscuits was conducted by 10 panelists according to the method of Johnson *et al*. (1989). The characteristics of biscuits include taste. The biscuit samples were evaluated after 24 hours of preparation by trained judges using a 9-point hedonic score system: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither liked nor disliked, 6 = liked slightly, 7 = liked moderately, 8 = liked very much, and 9 = liked extremely. Scores were collected and analyzed statistically.

d. **Statistical analysis:** The data were analyzed by analysis of variance (ANOVA) using completely randomized design and least significant difference (LSD) at 0.05 levels according to the method described by (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

a. Sprout Characters:

Sprout characters in Table 1 showed that using NaCl 2000 ppm solution resulted in a negative impact on sprouting percentage and sprout radical length compared with tap water. Data indicated also that there was no significant effect of water uptake imbibed for 9 hours, sprout fresh weight, or sprout dry weight. On the other hand, water uptake sprout 24 hours recorded the highest value under 2000 ppm NaCl. However, fenugreek seed sprouting for 24 hours in saline water recorded the highest sprouting characteristics compared to other crops except on sprout dry weight (gm/100 gm seed), which recorded the highest value with faba bean and wheat. These results indicate the negative effect of the salinity concentration of 2000 ppm on the studied traits, due to salinity inhibiting plant growth under the experimental conditions (Gupta, 2016; Ceritoglu *et al*., 2020). Moreover, several studies (Baci *et al*., 2003; Ibrahim *et al*., 2016; and Ilker, 2011) stated that abiotic stress, such as salinity or water stress, reduced water absorption in ryegrass, wheat, and barley.

The increase in salinity concentration of 2000 ppm decreased the length of the radical. The obtained results completely agree with the point of view for various sprouted grains like wheat, chickpea, lentil, fenugreek, faba bean, and clover (Abd El-Azim *et al*., 2019; Soliman, Basma *et al*., 2019; Gupta, 2016; Ali *et al*., 2019; and Aly, Tahany *et al*., 2021). Since the radical is in direct contact with the media and may directly absorb water or saline solutions from the media and supply them to the entire plant, it has a potent effect on salinity stress. In this sense, radical length provides great evidence for plant response to salt stress. (Carpıcı *et al*., 2009 and Ibrahim *et al*., 2016).

Table (1): Effect of NaCl at 2000 ppm on chickpea, fenugreek, wheat and faba bean sprout characters.

Salinity	Crop	Water uptake %		Radical length (mm)	Sprouting %	Sprout fresh weight (gm)	Sprout dry weight(gm)
		Imbibed 9hr	Sprout 24hr				
Cont.	Chickpea	124.44b	139.10c	14.87a	88.00ab	210.37c	78.52cd
	Fenugreek	209.09a	283.11b	14.60a	96.50a	369.70b	81.82bcd
	Wheat	42.26d	64.72e	6.73c	99.00a	163.06d	88.88ab
	Faba bean	83.92.c	99.05d	5.07d	56.67c	199.05c	91.32ab
	Mean	114.93A	146.49B	10.32A	85.04A	235.54A	85.13A
2000ppm	Chickpea	123.16b	139.57c	12.30b	81.33b	194.74c	73.19d
	Fenugreek	204.55a	310.89a	12.27b	96.25a	395.45a	81.82bcd
	Wheat	48.23d	65.92e	5.07d	94.00ab	155.09d	87.25abc
	Faba bean	81.51c	93.13d	3.23e	34.00d	193.13c	91.59a
	Mean	114.36A	152.38A	8.22B	76.40B	234.85A	83.46A
Average	Chickpea	123.80B	139.33B	13.58A	84.67B	202.55B	75.85B
	Fenugreek	206.82A	297.00A	13.43A	96.38A	382.58A	81.82B
	Wheat	45.25D	85.32D	5.90B	96.50A	159.58C	88.07A
	Faba bean	82.72C	96.09C	4.15C	45.33C	196.09B	91.45A
LSD 0.05	Salinity	3.694	5.695	0.583	6.323	9.359	4.336
	Crop	5.224	8.053	0.824	8.942	13.235	6.131
	Salinity x Crop	7.388	11.389	1.166	12.645	18.717	8.671

b- Macro elements analysis:

Macro element data in Table 2 showed that Phosphorus, Calcium, and Magnesium percentages recorded the lowest percentages under saline conditions; however, the other macro elements and protein percentages were better using saline water than control. Sprouted fenugreek flour analysis recorded maximum Nitrogen, Calcium, magnesium, and protein% compared to other crops except for Phosphorus% which recorded the highest value with faba bean and chickpea and Potassium with faba bean**.**

Table (2): Effect of salinity on (protein, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium) % of the tested sprouts powder seeds.

Salinity	Crop	Protein %	N%	P%	K%	Ca%	Mg%
Cont.	Chickpea	27.75d	4.44d	0.40a	0.74c	0.08d	0.18b
	Fenugreek	35.83b	5.73b	0.35b	0.66d	0.41a	0.21a
	Wheat	20.44e	3.27e	0.40a	0.23f	0.04e	0.17c
	Faba bean	36.32b	5.81b	0.40a	1.06b	0.02g	0.15d
	Mean	**30.09B**	**4.81B**	**0.39A**	**0.67B**	**0.14A**	**0.18A**
2000 ppm	Chickpea	29.38c	4.70c	0.40a	0.75c	0.10c	0.18b
	Fenugreek	41.32a	6.61a	0.30c	0.64e	0.26b	0.17c
	Wheat	21.20e	3.39e	0.30c	0.24c	0.02g	0.17bc
	Faba bean	36.38b	5.82b	0.40a	1.13a	0.03f	0.14e
	Mean	**32.07A**	**5.13A**	**0.35B**	**0.69A**	**0.10B**	**0.17B**
Average	Chickpea	28.56C	4.57C	0.40A	0.75B	0.09B	0.18B
	Fenugreek	38.58A	6.17A	0.33C	0.65C	0.34A	0.19A
	Wheat	20.82D	3.33D	0.35B	0.24D	0.03C	0.17C
	Faba bean	36.35B	5.82B	0.40A	1.10A	0.03D	0.15D
LSD 0.05	Salinity	0.478	0.074	0.005	0.010	0.003	0.004
	Crop	0.676	0.106	0.007	0.0113	0.004	0.005
	Salinity x Crop	0.957	1.149	0.011	0.019	0.006	0.07

c- Micro elements analysis:

Micro element analysis indicated that increasing salinity increased chlorine and sodium levels in the different tested plants. Iron, manganese, zinc, and copper recorded the lowest values under a saline condition. The sprouted fenugreek powder analysis recorded the highest sodium, iron, zinc, and copper ppm compared to the other crops except for chlorine, which recorded the highest value with faba bean, and manganese ppm, which recorded the highest value with wheat (Table (3).

Generally, increasing salinity to 2000 ppm indicates a positive effect of increased protein, nitrogen, potassium, chlorine, and sodium. Tables 2 and 3. These results completely agree with the point of view of various germinated grains like wheat, chickpea, lentil, clover, and faba bean. As reported by Abd El-Azim *et al.* (2019); Soliman, Basma *et al.* (2019); and Aly, Tahany *et al.* (2020).

Table (3): Effect of salinity on (Chlorine, Sodium) % (Iron, Manganese, Zinc, Copper) ppm of chickpea, fenugreek, wheat and faba bean sprouts powder.

Salinity	Crop	Cl%	Na%	Fe ppm	Mn ppm	Zn ppm	Cu ppm
Cont.	Chickpea	0.12f	0.09d	50.93f	18.88d	67.69c	10.56e
	Fenugreek	0.11g	0.07e	101.81a	15.51e	94.61a	25.71a
	Wheat	0.07h	0.05f	54.06de	26.99a	50.41f	6.79f
	Faba bean	0.13e	0.07e	61.61c	10.96g	42.47h	13.14b
	Mean	**0.11B**	**0.07B**	**67.11A**	**18.08A**	**63.80A**	**14.05A**
2000 Ppm	Chickpea	0.19b	0.33b	81.51b	20.16c	79.88b	11.48d
	Fenugreek	0.16c	0.48a	55.80a	11.78f	59.04d	10.66e
	Wheat	0.14d	0.07e	40.17g	25.85b	45.44g	6.54f
	Faba bean	0.33a	0.16c	52.96ef	11.25fg	53.75e	12.62c
	Mean	**0.20A**	**0.26A**	**57.61B**	**17.26B**	**59.53B**	**10.33B**
Average	Chickpea	0.15B	0.21B	66.22B	19.52B	73.79B	11.02C
	Fenugreek	0.14C	0.28A	78.80A	13.65C	76.83A	18.19A
	Wheat	0.11D	0.06D	47.12D	26.42A	47.93D	6.67D
	Faba bean	0.23A	0.12C	57.29C	11.11D	48.11C	12.88B
LSD 0.05	Salinity	9.451	0.003	1.131	0.339	1.093	0.257
	Crop	1.337	0.004	1.601	0.479	1.546	0.3693
	Salinity x Crop	1.890	0.006	2.264	0.678	2.187	0.513

d- Effect of mixed from sprouted wheat, chickpea and fenugreek flour on taste of biscuit products:

Data in Table 4 illustrates the effect of different levels of sprouted wheat, chickpea, and fenugreek flour on the mixed taste of biscuit products. These results indicate that the best biscuit taste was recorded by preparing biscuits from 100% market flour, followed by 100% whole wheat grain flour, then 100% sprouted wheat flour, and 50:50% sprouted wheat and faba bean flour. However, the lowest biscuit taste was prepared from 50: 25: 25% and 50: 37.5: 12.5% sprouted wheat, chickpea, and fenugreek flour.

Table (4): Effect of Mixed on Taste Biscuits Produced from Different Levels of Sprouted Wheat, Chickpea and Fenugreek Flour.

W, C, Fg Mixed%	Taste		Mean
	T1	T2	
Cont 1	8.50 a	8.50 a	8.50 A
Cont 2	7.80 ab	7.80 ab	7.80 B
100: 0: 0	7.30 bc	6.40 d	6.85 C
50: 25: 25	1.20 e	1.00 e	1.10 D
50: 37.5: 12.5	1.40 e	1.40 e	1.40 D
50: 50: 0	7.60 b	6.80 cd	7.20 C
Mean	5.63 A	5.32 B	-

Tap water (T1). Saline water (T2). Market flour (Cont1). Whole wheat grains flour (Cont2). Sprouted wheat flour (W). Sprouted chickpea flour (C). Sprouted fenugreek flour (Fg).

e- Different mixing ratios of sprouted wheat, chickpea and faba bean flour for producing biscuit:

The results in Table 5 showed that the best biscuit taste was prepared from sprouted seed flour in tap water compared to biscuits prepared from sprouted seed flour in saline water. Regarding the effect of the mixing ratio of sprout flour, Data showed that the best biscuit taste was prepared from 100% whole wheat grain flour and 100% market flour, followed by mixing ratios of 75: 12.5: 12.5%, 50: 25: 25%, and 50: 0: 50% of sprouted wheat, chickpea, and faba bean flour. While the lowest biscuit taste was recorded by the biscuit prepared from 100% sprouted wheat flour and 50% sprouted wheat and chickpea flour. These results are in agreement with the findings of Khattak *et al*., 2003 and 2006; Abd El Ghany *et al*., 2017; Ibrahim *et al*., 2017; Yadav *et al*., 2012; Guardianelli *et al*., 2019; Ungureanu-Iuga *et al*., 2021; and Van Toan and Tran, 2022. They reported increased consumers's acceptability of taste through grain sprouting and used other alternatives with wheat flour in the manufacture of biscuits to increase the nutritional value.

Table (5): Effect of Mixing Ratios on Taste Biscuits Produced from Different Levels of Sprouted Wheat, Chickpea and Faba bean Flour

W, C, Fb Mixed %	Taste		Mean
	T1	T2	
Cont1	8.60 a	8.60 a	8.60 A
Cont2	8.70 a	8.70 a	8.70 A
100: 0: 0	7.20 cd	7.00 d	7.10 C
75: 12.5: 12.5	8.20 ab	7.60 bcd	7.90 B
50: 25: 25	8.20 ab	7.50 bcd	7.85 B
50: 50: 0	7.60 bcd	7.40 bcd	7.50 BC
50: 0: 50	8.00 abc	7.60 bcd	7.80 B
Mean	8.07 A	7.77 B	-

Tap water (T1). Saline water (T2). Market flour (Cont1). Whole wheat grains flour (Cont2). Sprouted wheat flour (W). Sprouted chickpea flour (C). Sprouted faba bean flour (Fb).

Conclusion:

The study concluded that using NaCl 2000 ppm solution resulted in a negative impact on the characteristics of fresh sprouting. Chickpea, fenugreek, wheat, and faba bean recorded the shortest radical length and lowest sprouting percentage, while faba bean recorded the lowest data of water uptake under 2000 ppm compared with tap water and improved the quality of dry sprouted flour. Hence, it increased protein content, nitrogen, potassium, chlorine, and sodium. While reduced from iron, manganese, zinc, and copper ppm. Biscuit's taste prepared from sprouted seed flour by tap water was better than that prepared from sprouted seed flour by saline water. Mixtures of wheat, chickpea, and faba bean sprout flour can be used to produce biscuits, with the best mixing ratio of 12.5% chickpea and faba bean sprout flour to 75% wheat sprout flour. However, fenugreek sprout flour cannot be used in producing biscuits.

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