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Biofertilizers Effects on Chemical Composition, Rheological, Organoleptic and Quality Attributes of Wheat Balady Bread

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Abstract

The effect of inoculation by two bio-fertilizers, Rhizobium radiobacter and Candida incommunis, mixed with different levels of nitrogen fertilizer on vegetative growth of the winter wheat cultivar (Maser 1) was studied in the field experiment of sandy soil farm at 6th October Agriculture Company, El-Qasasin, Ismailia Governorate, Egypt. Results indicated that the addition of different levels of mineral N (25, 50, 75 and 100 kg N fed-1) and biofertilizers had significant effect on protein and carbohydrate of wheat bread. Increasing of protein and ash contents of bread made from wheat treated with biofertilizer than that the values of either whole grain or wheat flour and decreasing in the total carbohydrate. The increase in the mean value of P content was greater in yeast+ bacteria mixture (0.47%) than other treatments. Using yeast, bacteria and yeast + bacteria mixture resulted increase in K content of wheat grain with corresponding value of 0.58, 0.61 and 0.65%, respectively. The amount of Fe ranged from 46.90 to 62.8 mg/kg, 52.34 to 66.80 mg/kg and 54.36 to 67.00 mg/kg for yeast, bacteria and their mixture, respectively. The mean value of wheat grain contained 24.69 mg/kg of Zn for the mineral (control). mean value of Mn content of wheat grain with corresponding values of 41.83, 42.59 and 44.75 mg/kg, respectively. The data revealed that there is significant effect on the rheological characteristics, i.e., wet, dry gluten and gluten index between treatments and control. The mean value of wheat flour 82% showed that wet gluten amounted in 17.15% for the mineral (control). Wet gluten ranged from 18.52 to 19.23%, 16.78 to 17.01% and 17.35 to 17.92% as a result of treatment with yeast, bacteria and yeast + bacteria mixture, respectively. This study aimed to use different mineral nitrogen levels alone or combined with bio-fertilizers (Rhizobium radiobacter sp strain inoculation and Yeast) to enhance the growth yields of wheat and improve its chemical and physical properties and its nutrients component that reflects on the nutrients value of the balady bread offered to the Egyptian populations.

Keywords: wheat; biofertilizer; balady bread; rheological properties; dough

1. Introduction

The key objective for achieving high yields needs a wide use of chemical fertilizers, so farmers utilize chemical fertilizers frequently in spite of it being costly and causing environmental problems such as soil erosion problem [1]. Bio-fertilizers with their various kinds are microorganisms that play an advantageous role in forming a proper region around roots that promote growth of plants through facilitating uptake of minerals [2]. In agriculture, using chemical fertilizers is remaining the mainstay as respond to increasing requests for food in the world at present, thus, chemical fertilizers are used to supply wheat plants with the necessary elements [3]. Biofertilizers are significant for increasing yield in sustainable agriculture besides the reduction in quantity of chemical fertilizers [4]. These bio-fertilizers such as *Rhizobium radiobacter* preserve the

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root health by controlling pathogens and enhance the plant growth by absorption of nutrient elements [5].

Wheat (*Triticum aestivum* L.) is family of Poaceae (Gramineae), the vital cereal crops in world. Due to their exhaustive nature, these crops require more nutrients and have posed a great threat to a long term sustainability of higher production. Wheat contributes more calories, proteins, minerals, B-group vitamins and dietary fiber to diet than any other cereal crops. Because of the Egyptian national target is to raise the wheat productivity through increasing the planting area to decrease the gaps between wheat consumption and production [6].

From durum wheat, numbers of different foods product can be made, such as bulgur, pasta, bread [7]. According to plant fertilization, the quality of semolina and pasta are depending on the concentration of the protein confirmed by high doses of N fertilization and this needs good management for crop nutrition [8]. Egyptians yearly consume approximately 16 million tons of wheat, out of this quantity, 8.795 million/ton are cultivating in Egypt, while the rest amounts are import from outside [9].

Bread is the principal food and a stable for the majority of population, constituting an average of 70% daily caloric intake of the Egyptians. Balady bread is the most popular type of bread in Egypt, since 90% of the Egyptian families consume the subsidized balady bread in their daily meal.

Therefore, the present study aimed to utilizing the wheat cultivated in sandy soil in Egypt and treated with biofertilizers to raise their wheat productivity and quality, as well as, assess the effects of these biofertilizers on enhancing the wheat bread quality and studying the chemical composition, rheological, organoleptical and quality attributes of wheat Balady bread quality.

Materials and Methods

The experimental work was carried out in sandy soil farm at 6th October Agriculture Company, El-Qasasin, Ismailia Governorate, Egypt. The processing of balady bread part was carried out in the Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

Materials

The wheat grains variety (Masr 1) that used in this study were obtained from the Crop Institute, Agriculture Research Center, Giza, Egypt. The used mineral fertilizers were ammonium nitrate (33 %N) at rates of 25, 50, 75 and 100 kg N fed-1 applied three times, 21, 40 and 60 days after implant and two doses of potassium sulphate (48 % K2O) at 75 kg fed-1 rate applied after 21 and 45 days from planting. The bio-fertilizers Rhizobium radiobacter strain with accession number HQ395610 and Candida incommunis strain were obtained from the Department of Microbiology, Soils and Water Research Institute, Agricultural Research Center, Giza, Egypt. All other ingredients were obtained from local market.

Technological properties of wheat

Wheat grain flour extraction rate

Wheat flour extraction rate was conducted by conditioning the wheat grains at 14% moisture for 24 hr. The conditioned grains were milled using quadrant roller mill which fractionate the meal into flour soft bran and rough bran. Each fraction was weighed and calculated as a percentage [10].

Chemical Composition

Moisture, crude protein, fat and ash content were determined according to the methods described in A.O.A.C. [11].

Determination of Minerals Content

Minerals content including potassium (K), phosphorus (P), iron (Fe), zinc (Zn), and manganese (Mn), were digestion as described by Kirleis et al., [12] and determined by using the atomic absorption spectrophotometer (Perkin- Elmer 3300).

Rheological measurements

The rheological characteristics of wheat flour as dough stability, the degree of softening after 20 min, water absorption and the dough development time were determined using Farinograph-E, Brabender, Duisburg, Germany [13]. The absorption of water and kneading of the wheat flour were determined by mixing 50 g of wheat flour with some quantity of water. Over the time, the dough become resist against the mechanical stress and measured by the Farinogram torque. By using the Farinograph curves, the following parameters were determined which include, dough development time (DDT, time to reach maximum consistency), water absorption (% of water needed to give dough consistency of 500 FU), stability (duration time of dough consistency) and degree of softening (difference in FU) between the line of consistency and medium line of torque curve). While, the maximum resistance (Rmax), extensibility and extension energy were also determined by using Brabender Extensograph-E.

Determination of wet and dry gluten

Both of wet and dry gluten were determined according to the method of AACC [13] as follows: flour sample (10g) was put in a glutomatic wash chamber equipped with polyester sieve (88 micron). Sodium chloride (4.8 ml, 2% w/v) was mixed with the flour to form dough during 20 sec. followed by continuous washing (automatically) for 5 min. The separated wet gluten was transferred to special cassette and centrifuged at 6000 rpm/min. The fraction passed through the cassette or remained on the other side of the cassette were collected and weighed which was considered as wet gluten. The wet gluten was put in Glutork (type 2020) at 150°C for 4 min. to obtain the dry gluten. The percentage of gluten was calculated as follows:

Wet gluten *(%) = (Wet gluten weight)/ (Weight of sample) x*100

Dry Gluten *(%) = (Dry gluten weight)/ (Weight of sample) x*100

Gluten Index= *(Remainder gluten in casset)/ (Total gluten)*

Preparation of balady bread

The balady bread was prepared by follow the methods of Faridi and Rubenthaler [14] as follows: The balady bread formula consists of wheat flour (1Kg, 82% extraction rate), water (850 ml), fresh yeast (3% w/v) and salt (10g). The ingredient was well mixed for 10 min. The resulted dough was kept to ferment for 10 min, then divided into pieces (135g) which placed in a tray molded with layer of wheat bran and kept to ferment for 40 min. (final proofing). The dough spices were flatted to about 20 cm diameters and baked at high temperature oven (450-550°C) for 1-2 min. After baking, loaves were left to cool at room temperature before sensory evaluation.

Sensory evaluation of balady bread

The produced balady bread was evaluated for sensory characteristics by panelists from the staff of Bread and Pastry Res. Dep. Food Technology Research Institute, Giza, Egypt. The bread was organoleptically assessed for taste, odor, color, crumb color, texture, volume and the overall acceptability. The scoring scheme was established as mentioned by El-Farra et al. [15].

Statistical analysis

The data were statistically analyzed according to technique of variance analysis (ANOVA), for the split plot design. The different treatments were compared using the least significant difference (LSD) at percentage level of significance test which recorded by Waller and Duncan, [16] using IBM SPSS statistics version 19 software (IBM Corp., Armonk, NY, USA).

Result and Discussion

Wheat flour (82% extraction rate)

Data showed in Table (1) shown that, addition of different concentrations of mineral N and bio-fertilizers had significant effect on protein, carbohydrate and fat of wheat flour with 82% extraction rate. Comparison of the mean values of protein shows that, using of bacteria was the highest (12.46%), while, the control was the lowest (11.77%). The highest values of protein for soil treated with yeast, bacteria and mixture of bio-fertilizers combined with mineral nitrogen at rate 75 kg N/fed compared to the other treatments, this increasing maybe due to the bio-fertilizer influence.

In addition, the protein values of wheat flour ranged between 11.5 to 12.06% for soils received mineral N fertilizer levels, while they ranged between 12.13 to 12.5% for those combined with yeast. Also, they ranged from 12.19 to 12.69% for those combined with bacteria. Moreover, the protein ranged between 12.19 to 12.5% for soil treated with combined mixture (yeast+ bacteria). On the other hands, carbohydrate shows mean value of 86.31% for the control. It could be noticed that the treatment of (yeast + bacteria) resulted in slight increase over that of bacteria treatment, while slight decreases were noticed in control and yeast treatments.

TABLE 1
Effect of bio-fertilizers and different mineral nitrogen rate on the chemical composition of wheat flour (82% extraction rate)

Treatments	Mineral N fertilizer rate (kg/fed)	Protein (%)	Carbohydrate (%)	Fat (%)	Fiber (%)	Ash (%)
Mineral	25	11.5	86.63	0.57	0.39	0.91
	50	11.75	86.34	0.58	0.40	0.93
	75	11.75	86.31	0.60	0.40	0.93
	100	12.06	85.99	0.60	0.41	0.94
	Mean	11.77	86.31	0.59	0.40	0.93
Yeast	25	12.13	85.95	0.59	0.40	0.93
	50	12.44	85.61	0.59	0.41	0.95
	75	12.5	85.49	0.61	0.45	0.95
	100	12.44	85.53	0.62	0.45	0.96
	Mean	12.38	85.64	0.60	0.43	0.95
Bacteria	25	12.19	85.89	0.60	0.39	0.93
	50	12.38	85.67	0.61	0.40	0.94
	75	12.69	85.29	0.64	0.43	0.95
	100%	12.56	85.4	0.65	0.44	0.95
	Mean	12.46	85.55	0.63	0.42	0.94
Yeast+ bacteria	25	12.19	85.94	0.56	0.41	0.90
	50	12.31	85.75	0.62	0.42	0.90
	75	12.5	85.48	0.67	0.44	0.91
	100	12.44	85.5	0.69	0.44	0.93
	Mean	12.36	85.66	0.64	0.43	0.91
L.S.D., at 0.05 (Rate)		0.06	0.05	0.02	N.S	N.S
L.S.D., at 0.05 (Treatments)		0.07	0.05	0.03	N.S	N.S
Interaction		0.14	0.11	0.05	N.S	N.S

N.S.: None Significant

Wheat bread

Data tabulated in Table (2) revealed that the addition of different concentration levels of mineral N and bio-fertilizers had significant effect on protein and carbohydrate of wheat bread. In bread, the increasing of protein content was found due to using of the bio-fertilizer treatments, as well as, the increasing the consumption of carbohydrates by yeast in the fermentation process. Meanwhile, fat and fiber content show the similar trend of mean value results between treatments compared to control. Ash content shows increase than control. It could be recommended that, the use of (yeast+ bacteria) mixture followed by yeast and bacteria, the mixture has different enzyme activities and ability to fix nitrogen and other minerals from soil to plants. It could be concluded that, the using of bio-fertilizers improves the quality of the wheat grain which reflected in wheat flour and quality of bread. The data were in the line with the finding of El- Nagar, [17].

TABLE 2
Effects of bio-fertilizers and different mineral nitrogen levels on the chemical composition of balady bread

Treatments	Mineral N fertilizer rate (kg/fed)	Protein %	Carbohydrate %	Fat %	Fiber %	Ash %
Mineral	25	11.75	84.13	1.45	1.31	1.36
	50	12.19	83.64	1.49	1.32	1.36
	75	12.44	83.35	1.50	1.35	1.39
	100	12.5	83.24	1.51	1.35	1.40
	Mean	12.22	83.59	1.49	1.33	1.38
Yeast	25	12.25	83.48	1.51	1.34	1.42
	50	13.5	82.18	1.50	1.36	1.46
	75	13.63	82.0	1.53	1.36	1.48
	100	13.56	81.99	1.56	1.39	1.50
	Mean	13.24	82.41	1.53	1.36	1.47

Bacteria	25	12.31	83.44	1.50	1.34	1.41
	50	13.13	82.56	1.52	1.34	1.45
	75	13.31	82.35	1.52	1.35	1.47
	100	13.25	82.35	1.54	1.36	1.50
	Mean	13.0	82.67	1.52	1.35	1.46
Yeast+ bacteria	25	13.13	82.62	1.46	1.36	1.43
	50	13.19	82.54	1.46	1.36	1.45
	75	13.38	82.27	1.51	1.38	1.46
	100	13.31	82.19	1.55	1.39	1.56
	Mean	13.25	82.4	1.50	1.37	1.48
L.S.D., at 0.05 (Rate)		0.05	0.42	N.S.	N.S.	0.03
L.S.D., at 0.05 (Treatments)		0.05	0.49	N.S.	N.S.	N.S.
Interaction		0.01	N.S.	N.S.	N.S.	0.06

N.S.: None Significant

Effect of different types of bio-fertilizers and nitrogen mineral fertilizer on mineral content of wheat grains, flour and bread

1. Wheat grain

Data in Table (3) show the contents of phosphorus (P), iron (Fe), potassium (K), manganese (Mn) and zinc (Zn) in wheat grains. The all minerals contents of wheat grains were significant increasing by all treatments. The increase in the mean value of P content was greater in (yeast+ bacteria) mixture (0.47%) than the other treatments. The lowest mean value of wheat grain phosphorus recorded as 0.37% for the mineral (control) [18].

Concerning K content, the control treatment shows a mean value of 0.50%. The using of yeast, bacteria and mixture of (yeast+ bacteria) results in increasing of wheat grain K content with corresponding values 0.58, 0.61 and 0.65%, respectively. The mean value of wheat grain Fe of control was 50.76 mg/kg and the amount ranged from 46.90 to 62.8 mg/kg, 52.34 to 66.80 mg/kg and 54.36 to 67.00 mg/kg for yeast, bacteria and their mixture, respectively. The mean value of wheat grain of Zn of control was 24.69 mg/kg. It worth to notice that all treatments increased Zn in wheat grain which found in the same trend as that of Mn. The using of yeast, bacteria and mixture of (yeast+ bacteria) results in increasing the mean value of Mn content of wheat grain with corresponding values of 41.83, 42.59 and 44.75 mg/kg, respectively. This may be due to the releasing of more available micronutrients to be absorbed by plant roots caused by the organic acids which produced from the microorganisms and resulted in decreasing of soil pH [19].

TABLE 3

Effects of bio-fertilizers and different mineral nitrogen rates on minerals content of wheat grains

Treatments	Mineral N fertilizer rate (kg/fed)	P (%)	K (%)	Fe	Zn mg/kg	Mn
Mineral	25	0.28	0.45	44.70	22.77	35.70
	50	0.33	0.48	48.22	24.60	38.12
	75	0.40	0.53	53.11	25.12	40.16
	100	0.45	0.55	57.00	26.33	45.18
	Mean	0.37	0.50	50.76	24.69	39.79
Yeast	25	0.30	0.46	46.90	24.00	36.80
	50	0.35	0.53	53.11	27.00	41.22
	75	0.49	0.67	62.80	33.10	43.70
	100	0.44	0.66	59.00	31.20	45.60
	Mean	0.41	0.58	55.45	28.83	41.83
Bacteria	25	0.32	0.50	52.34	25.60	37.21
	50	0.41	0.57	56.36	30.40	42.35
	75	0.53	0.71	66.80	40.00	44.80
	100	0.46	0.67	60.24	39.00	46.00
	Mean	0.43	0.61	58.94	33.75	42.59
Yeast +bacteria	25	0.35	0.53	54.36	30.22	39.60
	50	0.43	0.60	58.60	40.50	44.30
	75	0.52	0.75	67.00	45.00	47.10
	100	0.58	0.70	61.36	44.30	48.00
	Mean	0.47	0.65	60.33	40.01	44.75
L.S.D., at 0.05 (Rate)		0.04	N.S	0.02	0.14	1.04
L.S.D., at 0.05 (Treatments)		0.08	0.04	1.09	0.09	0.08
Interaction		N.S	N.S	0.35	0.27	0.08

N.S.: None Significant

Inoculation with bio-fertilizer strains enhanced the solubility of the added rock P and K to be more easy to uptake by plant roots [20]. Also, the high amount of P and K that uptake subsequently promoted the plant growth. Therefore, the function of KSB (potassium solubilizing bacteria) is to increase the availability of potassium in soil and hence increase its plant content. This study suggests, that the plant growth development is related to both increasing K solubility due to the effect of the solubility K strains as well as increasing the uptake of P. Other study reported that, the inoculated bacteria increase the plant growth, nutrient uptake, and yield of maize plants [20]. In addition, Sheng et al. [21] reported that, the potassium released was affected by pH, dissolved oxygen and strains used. Also, application of potassium solubilizing bacteria increase K availability in soil and also increases the mineral uptake by plant. Ahmed et al. [22] found that application of bio-fertilizer combined with nitrogen fertilizer led to increasing the N, P and K content in guar plants. Mahfouze and Sharaf-Eldin, [23] found that, the bio-fertilization of Egyptian soil decreasing the pH, and increasing the availability of trace elements that enhance the plant growth.

2. *Wheat flour (82% extraction rate)*

The data in Table (4) indicate the effect of yeast, bacteria and their mixture on the mineral content (mg/kg) of wheat flour (82% extraction rate). The mineral contents of wheat flour (82% extraction rate) were significant increased by all used treatments. The mean value of wheat flour phosphorus recorded 0.28% for the control. The highest mean value of P content was in (yeast+ bacteria) mixture (0.34%) than the other treatments. The lowest mean value of wheat flour phosphorus recorded 0.28% for control.

TABLE 4

Effects of bio-fertilizers and different mineral nitrogen rates on minerals content of wheat flour (82% extraction rate)

Treatments	Mineral N fertilizer rate (kg/fed)	P (%)	K (%)	Fe	Zn mg/kg	Mn
Mineral	25	0.21	0.29	30.1	17.80	20.31
	50	0.28	0.30	34.21	18.00	20.54
	75	0.31	0.31	36.14	18.13	20.93
	100	0.36	0.36	39.00	18.55	21.11
	Mean	0.28	0.32	34.86	18.12	20.73
Yeast	25	0.25	0.39	43.19	19.03	20.84
	50	0.29	0.49	50.00	19.83	21.25
	75	0.44	0.56	55.91	20.05	22.04
	100	0.43	0.54	54.14	19.91	21.91
	Mean	0.35	0.49	50.81	19.71	21.51
Bacteria	25	0.28	0.40	42.01	20.33	21.19
	50	0.38	0.51	50.88	20.41	22.31
	75	0.46	0.65	56.91	21.11	23.18
	100	0.42	0.64	54.04	20.58	22.86
	Mean	0.38	0.55	50.96	20.60	22.38
Yeast +bacteria	25	0.30	0.45	49.34	21.57	22.21
	50	0.38	0.52	55.03	21.71	22.94
	75	0.55	0.67	58.51	22.08	23.91
	100	0.49	0.64	56.93	21.71	23.25
	Mean	0.43	0.57	54.95	21.80	23.07
L.S.D., at 0.05 (Rate)		N.S	N.S	N.S	N.S	0.10
L.S.D., at 0.05 (Treatments)		0.05	N.S	0.03	0.30	1.11
Interaction		N.S	N.S	N.S	N.S	0.80

N.S.: None Significant

The content of K showed a mean value of 0.32% for the control treatment. All treatments resulted in highly significant increase than the control. Fe content showed a mean value of 34.86 mg/kg for the control treatment. Meanwhile, other treatments showed a significant increase compared to control. Fe amount ranged from 34.19 to 55.91, 42.01 to 56.91 and 49.34 to 58.51 mg/kg, respectively, for yeast, bacteria and their mixture. Zn content showed a mean value of 18.12 mg/kg for the control. All treatments showed an increase compared to control. Mn content showed a mean value of 21.11 mg/kg for the control. All treatments showed an increase compared with control. In addition to, the highest value of minerals content of soil treated with bio-fertilizers combined with mineral nitrogen at rate 75 kg N/ fed.

3. Wheat bread

Table (5) show the mineral content of wheat bread produced from wheat fertilized with yeast, bacteria and their mixture under the recommended dose of nitrogen mineral fertilization. The minerals content (Fe, Zn and Mn) of wheat bread were significant increased by all treatments. The mean value of wheat bread P recorded 0.35% for the mineral (control). It ranged from 0.28 to 0.46, 0.40 to 0.49 and 0.33 to 0.56% as a result of fertilized with yeast, bacteria and their mixture, respectively. K content showed a mean value of 0.37% for the control treatment.

TABLE 5

Effects of bio-fertilizers and different mineral nitrogen rate on minerals content of wheat bread

Treatments	Mineral N fertilizer rate (kg/fed)	P (%)	K (%)	Fe	Zn (mg/kg)	Mn
Mineral	25	0.25	0.34	40.32	19.14	21.41
	50	0.30	0.36	40.91	20.14	22.30
	75	0.38	0.37	41.03	21.53	24.56
	100	0.40	0.40	41.14	21.96	26.76
	Mean	0.35	0.37	40.84	20.72	23.76
Yeast	25	0.28	0.40	44.88	20.34	22.51
	50	0.32	0.50	51.93	22.05	23.66
	75	0.46	0.59	56.22	24.49	25.19
	100	0.45	0.56	55.81	23.65	24.35
	Mean	0.37	0.51	52.21	22.64	23.93
Bacteria	25	0.40	0.46	42.34	22.41	24.40
	50	0.45	0.56	42.74	27.94	26.11
	75	0.49	0.67	57.22	31.01	28.89
	100	0.48	0.66	52.96	28.38	28.19
	Mean	0.45	0.58	48.81	27.45	26.90
Yeast +bacteria	25	0.33	0.55	50.76	23.55	24.40
	50	0.42	0.56	55.53	23.05	25.11
	75	0.56	0.74	59.11	24.77	25.93
	100	0.55	0.70	57.34	23.13	25.43
	Mean	0.46	0.64	55.69	23.63	25.22
L.S.D., at 0.05 (Rate)		N.S	N.S	0.09	0.02	0.14
L.S.D., at 0.05 (Treatments)		N.S	N.S	0.11	0.03	0.13
Interaction		N.S	N.S	0.20	0.05	0.28

N.S.: None Significant

The mean value content of Fe was 40.84 mg/kg for control treatment, and the high increase in Fe amount was found in all treatments. Zn content shows a mean value of 20.72 mg/kg for the control, it could be found that all treatments show an increasing compared to control. Mn shows an increase in all treatments compared to control and the highest mean value of Mn content was in bacteria (26.90 mg/kg) compared to other treatments.

The application of organic fertilizer with mineral fertilizer gave an increasing in N, K and P content compared to adding organic fertilizer alone. The percentages of nitrogen, phosphorus, potassium and crude protein significantly increased by inoculation of wheat grain with Azos., yeast and Azos. + yeast when compared with control treatment (without inoculation) during the two seasons [24]. This may be due to the important role of nitrogen fixation bacteria on increase of the endogenous phytohormones (IAA, GAS and SKS) that play a vital role in the active root formation, increase of the nutrients uptake, and increasing the photosynthesis rate [25].

El-Kholy and Omar, [26] found that the wheat grain inoculated with nitrogen fixing bacteria (*Bacillus polymyxa, Azospirillum brasilense and Azospirillum lipoferum*) and two strains of yeast (*Saccharomyces cerevisiae and Candida utilis*) with nitrogen fertilization at El-Serw province (Damitta Governorate) had effect on both yield and nitrogen content of plants. This describe the weakens of the natural adherence in the cortex tissue of the inoculated roots, where, this will increase the mineral over the adsorption surface of the cortex cells by some kind of sponge effect then increasing N, P and K uptake. These useful effects result in increasing accumulation of dry matter and minerals in plants and economic plant parts, and cause a significant increase in yield. The nutrient status of grain shows high N, P and K contents in the plants treated with *Azospirillum brasilense* [27]. The highest values of nitrogen, phosphorus, potassium contents and protein percentage were recorded by using the full recommended dose of NPK (F5) with yeast inoculation. However, the lowest values of nitrogen, phosphorus, potassium contents and protein percentage were recorded by F1 with non-inoculation. This may be as a result of enhancing the metabolic activity of the plant root when mineral nutrients are supplied through the fertilizers addition to the soil [28].

The using of high rate of nitrogen and bio-fertilizers will increase the protein content compared to control [29]. Other study reported that, using of vermiculite under different treatments of N-sources resulted in increase of P, K and N uptake in straw up to 13.6, 15 and 15.5%, respectively, and also increase in NPK-uptake by grain up to 18.5, 21.3 and 19.4%, respectively. Our results are the same with results obtained by Merwad et al. [30] who reported that the using of vermiculite under organic treatments improve NPK-uptake by straw and grain of barley cultivated in sandy soil.

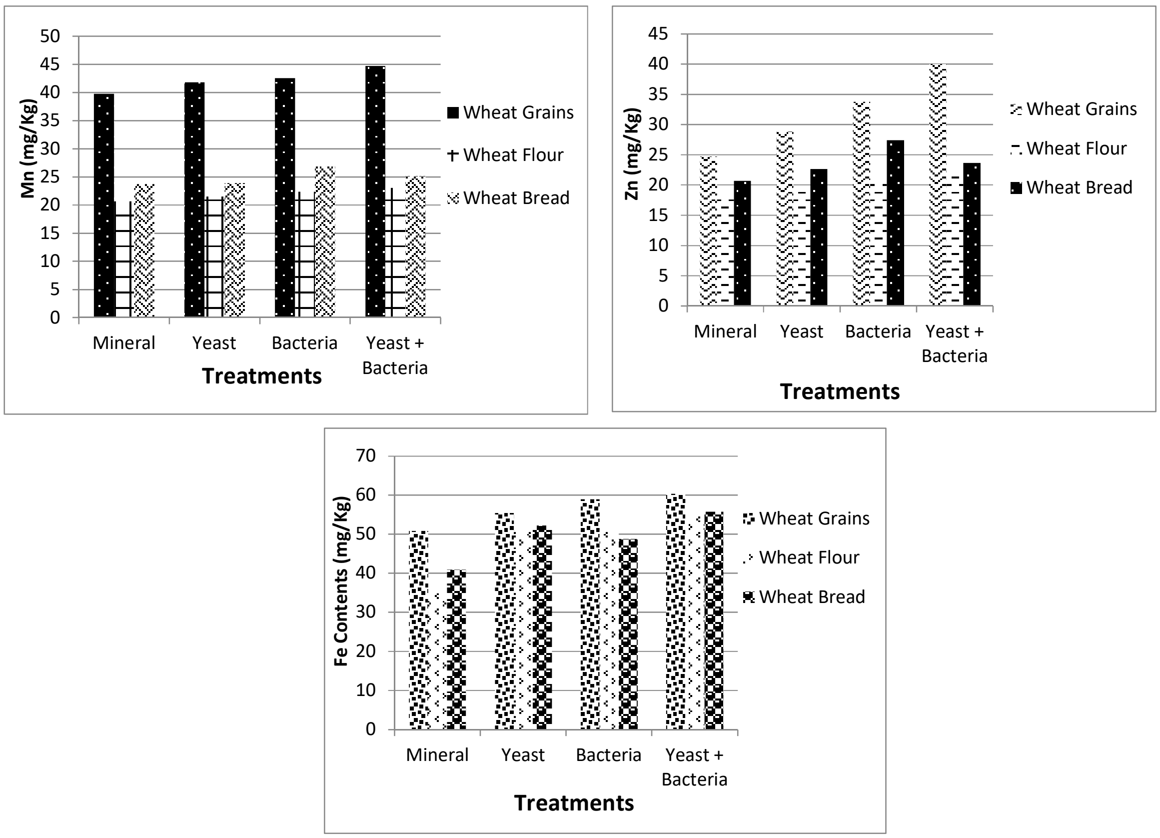

Fig. 1: Effect of bio-fertilizers and different mineral nitrogen rates on minerals content of wheat grain, flour and wheat bread

Effect of different types of bio-fertilizers and nitrogen mineral fertilization on the rheological characteristics of wheat flour 82% extraction rate

Table (6) shows the effect of different types of bio-fertilizers on the rheological parameter of wheat flour. The data revealed that there was significant effect on the rheological characteristics, i.e., wet, dry gluten and gluten index between treatments and control. This may be due to the bio-fertilizer treatments considered as natural fertilizer. The data were in the line with those reported with Toaima et al. [31] showed significant in rheology parameter. Wet gluten content and sedimentation value in wheat flour tended to increase with the increase of the amount of nitrogen fertilizer.

The mean value of wheat flour 82% showed that wet gluten amounted in 17.15% for the mineral (control). Wet gluten ranged from 18.52 to 19.23%, 16.78 to 17.01% and 17.35 to 17.92% as a result of treatment with yeast, bacteria and (yeast + bacteria) mixture, respectively. Which resulted dry gluten with a range of 7.02 to 8.12, 5.75 to 6.16 and 6.32 to 6.93%, respectively? Similar trend was found concerning gluten index. Moreover, when wheat flour mixed with water to dough forming, the matrixes of protein in the individual cells are forming continuous network that converses the necessary of viscoelasticity to get high-quality bread [32]. Using yeast in this study showed high mean value of wet and dry gluten content of 18.94 and 7.58%, respectively. Ohm and Chung, [33] reported that the quantity and quality of proteins determined by the content and quality of proteins determined by the content and quality of gluten. With respect of gluten index, it is depending on the amount of wet gluten that crosses the sieves under centrifugal force, while a higher proportion of gluten still remains on the sieve after centrifugation indicating this gluten formed was strong [34]. Gluten index decreased from 79.45% (yeast) to 75.6% (bacteria). This finding agrees with Enriquez et al. [35] reported that, the optimum gluten index value for baked purposes should between 60 and 90%. Also, they established that, there is not any correlation between wet gluten and gluten index.

TABLE 6

Effects of bio-fertilizers and different mineral nitrogen rates on the rheological properties of wheat flour (82% extraction rate)

Treatments	Mineral N fertilizer rate (kg/fed)	Wet Gluten (%)	Dry Gluten (%)	Gluten Index (%)
Mineral	25	16.84	5.81	75.1
	50	16.95	5.91	75.7
	75	17.00	6.13	76.2
	100	17.82	6.80	76.8
	Mean	17.15	6.16	75.95
Yeast	25	18.52	7.02	78.7
	50	18.83	7.18	79.1
	75	19.18	8.00	79.8
	100	19.23	8.12	80.2
	Mean	18.94	7.58	79.45
Bacteria	25	16.78	5.75	75.1
	50	16.82	5.80	75.5
	75	16.91	5.87	75.8
	100	17.01	6.16	76.0
	Mean	16.88	5.89	75.6
Yeast +bacteria	25	17.35	6.32	76.9
	50	17.53	6.40	77.5
	75	17.73	6.54	77.6
	100	17.92	6.93	77.8
	Mean	17.63	6.55	77.45
L.S.D., at 0.05 (Rate)		0.71	0.59	1.61
L.S.D., at 0.05 (Treatments)		0.29	0.35	1.17
Interaction		0.48	0.43	2.58

The percentage range of water absorption was found to be 73.0 to 78.5%, 76.4 to 80.0% and 69.0 to 77.4% in yeast, bacteria and their mixture, respectively. Our results were found the water absorption increase by increasing addition of bacteria that reduce the dough blends stability. On the other hand, the highest stability was found with (yeast+ bacteria) mixture flour than that of the other treatments (Table 7).

Kulp and Lorenz, [36] indicated that, the addition of bacteria led to increasing in water absorption rates, and not effect on the dough development time, this may be due to no newer bonds formation due to generation of strong intermolecular electrostatic repulsive forces [35]. From farinogram results, the degree of dough softening was in¬creased by increasing the concentration level of bacteria (Table 5), this results were in agreement with the findings results of Clarke et al. [37].

Extensograph data presented in Table (7) show some properties namely, the elasticity, extensibility, P. N and energy were significant. The results of extensograph parameters showed that the addition of (yeast + bacteria) mixture to the wheat flour reduced dough extensibility. The data revealed that as the increasing level of bacteria + yeast, decrease the extension resistance due to the raising of proteolytic activity and gluten degradation that results in loss of extension resistance. The generated energy value of mixing of wheat flour with yeast plus (yeast + bacteria) mixture was decreased.

According to, the obtained results, an overall improvement bacterium with yeast addition not change the bread physical properties including volume and density, while, decrease the dough inability and functionality including: resistance to extension, dough consistency, extensibility, elasticity during the bread processing. Clarke et al. [38] detected reduction in dough extensibility with lactic acid and the mixed sourdough not have the same effects of addition of single-strain sourdough. Other study reported, a slight decreasing in extensibility and deformation energy of dough containing dehydrated sourdough [36]. Our results were in agreement with results of Tafti et al. [39] who reported no significant difference in energy values between sourdough levels.

TABLE 7

Effect of bio-fertilizers and different mineral nitrogen rates on rheological properties of dough

Treatments	Mineral N fertilizer rate (kg/fed)	Farinograph					Extensograph			
		Water Absorption (%)	Arrival time (min)	Dough Development (min)	Stability (min)	Degree of Softening (B.U)	Elasticity (BU)	Extensibility (mm)	P.N	Energy (cm2)
Mineral	25	70.0	1.5	2.0	4.0	50	180	100	1.80	40
	50	73.0	2.0	2.5	4.5	80	200	90	2.22	45
	75	77.0	2.0	3.0	5.5	50	210	120	1.75	48
	100	78.5	1.0	1.5	4.0	100	190	130	1.46	46
	Mean	74.63	1.63	2.25	4.5	70	195	110	1.81	44.75
Yeast	25	73.0	1.5	1.5	2.5	80	150	80	1.87	35
	50	75.5	2.0	2.5	3.0	70	190	95	2.00	34
	75	76.0	1.0	1.5	4.5	70	200	115	1.74	42
	100	78.5	1.5	2.0	6.0	50	220	135	1.63	61
	Mean	75.75	1.5	1.87	4.0	67.5	190	106.25	1.81	43
Bacteria	25	76.4	1.5	2.0	4.5	70	220	120	1.83	50
	50	77.5	1.5	2.0	5.5	50	220	110	2.00	50
	75	78.0	2.0	2.5	3.5	90	190	117	1.62	45
	100	80.0	1.5	2.0	2.5	90	160	125	1.28	39
	Mean	77.98	1.63	2.13	4.0	75.0	197.5	118	1.68	46
Yeast + Bacteria	25	69.0	1.0	1.5	4.5	40	180	100	1.80	43
	50	70.0	1.5	2.0	5.5	50	200	90	2.22	45
	75	72.0	1.5	2.0	6.0	50	230	100	2.30	46
	100	77.4	1.5	2.0	4.0	70	190	110	1.73	38
	Mean	72.1	1.38	1.88	5.0	52.5	200	100	2.01	43
L.S.D., at 0.05 (Rate)		5.59	0.31	0.58	0.72	1.28	10.51	10.56	0.43	3.45
L.S.D., at 0.05 (Treatments)		5.78	0.74	0.81	1.14	2.81	14.93	7.05	0.51	7.067
Interaction		N.S	0.62	N.S	N.S	2.56	21.02	21.1	0.86	6.91

N.S.: None Significant

Effect of different types of bio-fertilizers and nitrogen mineral fertilizer on sensory characteristics

Data in Table (8) shows the effects of different types of bio-fertilizers and nitrogen mineral fertilization on sensory characteristics of balady bread was Non-significant. The sensory evaluation included the general appearance, taste, crust color, separation of layers, roundness, distribution of crumb and odor. Results of the sensory evaluation in Table (8) showed enhancing the intensity of bread taste compared with the yeast fermentation [40]. Shadi et al. [41] found that L plantarum was added to bread dough formulation at 0,5,10 and15% concentrations, showed that the highest score of taste were belonged to sample contained 5% sourdough while sample with 15% sourdough gained highest score of bread odor. The sensory properties of balady bread were increased between treatments compared with control bread. This result agrees with that reported by Gomez et al. [42].

TABLE 8

Effects of bio-fertilizers and different mineral nitrogen rates on sensory characteristics

Treatments	Mineral N fertilizer rate (kg/fed)	General Appearance (20)	Taste (20)	Crust Color (15)	Separation of layers (15)	Roundness (10)	Distribution of crumb (10)	Odor (10)
Mineral	25	17	19	13.5	14	9	9.5	9
	50	17	19	13	14	9	9.5	9
	75	17	19	13	14	9	9.5	9
	100	17	19	13	14	9	9.5	9

	Mean	17	19	13.1	14	9	9.5	9
Yeast	25	18	19	14	14	9	9	9
	50	18	19	14	14	9	9	9
	75	18	19	14	14	9	9	9
	100	17.5	19.5	14	14	9	9.5	9
	Mean	17.9	19.1	14	14	9	9.13	9
Bacteria	25	19	19.5	14	14	9	9	9
	50	19	19.5	14	14	9	9.5	9
	75	18	19	14.5	14	9	9.5	9
	100	18	19.5	14.5	14	9.5	9.5	9
	Mean	18.5	19.4	14.2	14	9.13	9.38	9
Yeast+ bacteria	25	18	18.5	14	14	9	9	9
	50	17.5	18.5	14	14	9	9	9
	75	17.5	19	14	14	9	9	9
	100	17.5	19	14	14	9	9	9
	Mean	17.6	18.7	14	14	9	9	9
L.S.D., at 0.05 (Rate)		N.S	1.35	N.S	N.S	N.S	1.49	2.42
L.S.D., at 0.05 (Treatments)		1.58	0.97	1.19	N.S	N.S	1.09	2.82
Interaction		1.82	1.35	N.S	N.S	N.S	N.S	N.S

N.S.: None Significant

Conclusion

From the collected data in the current investigation, it can be concluded that inoculating of wheat grains with bio-fertilizers Rhizobium radiobacter and Candida incommunis or the combination between them with doses of nitrogen fertilizer caused increasing of wheat growth, improve the wheat quality and increase the wheat nutritional values. Therefore, increase the nutrients of the produced balady bread and enhance its sensory characteristics.

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Compliance with the ethical statement

All authors of this paper have no conflict of interest with one or organization.

References

1. Salim H.A., Ali A.F., Alsaady M.H.M., Saleh U.N., Jassim N.H., Hamad A.R., Attia J.A., Darwish J.J., and Hassan A.F., Effect of plant growth promoting rhizobacteria (PGPR) on growth of cauliflower (Brassica oleracea L.Var. Botrytis). Plant Archives, 20(1), 782-786 (2020).
2. Alsaady M.H.M., Salim H.A., Abdulrazzaq A.K., Saleh U.N., Jassim N.H., Hamad A.R., Attia J.A., Darwish J.J., and Hassan A.F., Response of cabbage plants to foliar application of yeast suspension and nitrogen fertilizer. Eco. Env. & Cons., 26(2), 832-836 (2020).
3. Salim H.A., Mutlag K.H., Ali A.F., Sadik M.R., Zedan D.A., Rosoki B.O., and Gasam H.S., The response of wheat (Triticum aestivum L.) to inoculation of chemical fertilizers and bio fertilizers (combination of Azotobacter chroococcum and Pseudomonas fluorescens). Third national feminist scientific conference, 212-218 (2019).
4. Al-Erwy A.S., Al-Toukhy A., and Bafeel S.O., Effect of Chemical, Organic and Bio Fertilizers on photosynthetic pigments, carbohydrates and minerals of Wheat (Triticum aestivum. L) Irrigated with Sea Water. Int. J. Adv. Res. Biol. Sci., 3(2), 296-310 (2016).
5. Vessey J.K., Plant growth promoting rhizobacteria as biofertilizers. Plant and Soil, 255, 571-586 (2003).
6. El-Metwally I.M., Ramadan E., Abdelraouf M. A., Ahmed O. M., Juan J. A., and Magdi T. A., Response of wheat (Triticum Aestivum L.) crop and broad-leaved weeds to different water requirements and weed management in sandy soils. Agriculture (Pol`nohospodárstvo), 61 (1), 22-32 (2015).
7. Paˇcuta V., Rašovský M., Michalska-Klimczak B., and Wyszynski, Z., Grain Yield and Quality Traits of Durum Wheat (Triticum durum Desf.) Treated with Seaweed- and Humic Acid-Based Biostimulants. Agronomy, 11, 1270 (2021).
8. Laurent E. A., Ahmed N., Durieu C., Grieu P., and Lamaze T., Marine and fungal biostimulants improve grain yield, nitrogen absorption and allocation in durum wheat platns. J. Agric. Sci. 158, 279–287 (2020),
9. Samy A. H., Samira A., Osman A., Sara E., Eldessouky I., Atef A., Haiba A., and Rania A.T., Genetic and biochemical studies on some Egyptian wheat genotypes under drought stress. Bulletin of the National Research Centre, 45,151 (2021)

10. AOAC., Association of official agricultural chemists, official and tentative methods of analysis, 11th ed. Washington, D.C., USA. (2000).
11. AOAC. Official Methods of Analysis of Association of Official Chemists. 18th Ed., Washington, D.C., USA. (2010).
12. Kirleis A.W., Sommers L.E., and Nelson D.W., Yield, heavy metal content and milling and baking properties of soft red winter wheat grown on soils amended with sewage sludge. Cereal Chemistry, 61(6), 581-522 (1984).
13. AACC., Approved Method of the AACC. 10th ed., American Association of Cereal Chemists, INC. St., Paul, Minnesota, USA. (2000).
14. Faridi H.A., and Rubenthaler G.L., Effect of baking time and temperature on bread quality, starch gelatinization and staling of Egyptian method of the American Association of cereal chemists. Published by American Association of Cereal Chemists. Inc. St. Paul, Minnesota, U.S.A. (1984).
15. El- Farra A.A., Khorshid A., Mansour S.M., and Galal A.M., Studies on the possibility of supplementation of balady bread with various commercial soy products, pp.9.1st. Egypt Conference on Bread Res. (1982).
16. Waller R.A., and Duncan D. B., A bayes rule for the symmetric multiple comparison problems. Journal of the American Statistical Association, 64, 1484-1504 (1969).
17. El-Nagar G.R. Integrating of mineral and bio-fixed nitrogen fertilization in maize production under different irrigation regimes. Assiut Journal of Agricultural Sciences, 34(5), 53-76 (2003).
18. Mahmoud K.Gh. M., El-Sokary M.M.M., Scholkamy TH., Abou El-Roos M.E.A., Sosa G.A.M., and Nawito M. Effect of cryodevice type and cryoprotectant concentration on vitrified buffalo oocytes at MII stage. Anim. Reproduction, 10, 689-696 (2013).
19. Subb-Rao N.S., Bio-fertilizers in Agriculture. Oxford and IBH Publishing Co. New Delhi, Bombay, Calcutta (1981).
20. Han H. S., and Lee K. D., Plant growth promoting rhizobacteria status, photosynthesis, mineral uptake and growth of lettuce under soil salinity. Res. J. Agric. Biol. Sci., 1, 210-215 (2005).
21. Sheng Z., Helm D.C., and Li J., Mechanisms of earth fissuring caused by groundwater water with drawal. J. Environmental and Engineering Geosciences, 9(4), 313-324 (2003).
22. Ahmed S.H.G., Hussein, A.H.S., Abeer, A.M. and Hanaa, F.Y.M., Effect of nitrogen sources, bio-fertilizers and their interaction on growth, seed yield and chemical composition of guar plants. Life Science Journal, 10, 389-402 (2013).
23. Mahfouz, S.A. and Sharaf-Eldin, M.A. Effect of mineral and bio-fertilizer on growth, yield, and essential oil content of fennel (foeniculum vulgare mill.). Int. Agrophysics, 21, 361-366 (2007).
24. Yassen A. A., El-Hady M. A., and Zaghloul S. M., Replacement part of mineral N fertilizer by organic ones and its effect on wheat plant under water regime conditions. World J. Agric. Sci. 2(4), 421-428 (2006).
25. Zaki M., Hassanein M.S. N., and Gamal El-Din K.M., Growth and yield of some wheat cultivars irrigated with saline water in newly cultivated land as affected by bio- fertilization. J. of Applied Sci., 10, 1121-1126 (2007).
26. El-Kholy M.H., and Omar M.N.A., Growth response of wheat as affected by yeast and some diazotrophs inculcation under two levels of nitrogen fertilizer. In: International Symposium on Nitrogen Fixing and Crop Production, Cairo, Egypt, May 11-13, 1999, FAO Ed. (2000).
27. Hosam El-Din A.T.S., Productivity of some wheat varieties by using bio and organic fertilization in new valley. M. Sc. Thesis, Fac. of Agric. Ain Shams. Univ., Egypt. (2007).
28. Abd El-Hafez G.A., and Abo El-Soud A.A., Response of two soybean cultivars to different levels of organic fertilizer (compost). J. Agric. Sci. Mansoura Univ. 32, 8575-8588 (2007).
29. Abedi T., Alemzadeh A., and Kazemeini S.A., Effect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat. AJCS., 4(6), 384-389 (2010).
30. Merwad A.M.A., Awad E.A.M. Mohamed I.R., and Dahdouh, S.M.M., Effect of some phosphatic fertilizers and soil amendments on the availability of phosphorus in soil. Zagazig J. Agric. Res., 40, 483-494 (2013).
31. Toaima S.E., Amal A., El-Hofi A., and Ashoush H., Yield and technological characteristics of some wheat varieties as affected by N fertilizer and seed rates. Mansoura Univ., J. Agric. Sci., 25(5), 2449-2467 (2000).
32. Fadda M., Bertelli D., Martelli M., Marcacci M., Dario M., Paggetti C., Caramella D., and Trippi D., Computer assisted planning for total knee arthroplasty. In: Troccaz, J., Grimson, E., Mo¨sges, R. (Eds.), CVRMed-MRCAS '97: First Joint Conference Computer Vision, Virtual Reality and Robotics in Medicine and Medical

Robotics and Computer-Assisted Surgery. Springer, Grenoble, France, pp. 619–628 (1997).
33. Ohm J.B., and Chung O.K., Gluten, pasting and mixograph parameters of hard winter wheat flour in relation to bread making. Cereal Chem., 76(5), 606–613 (1999).
34. Dowell J.A., Frost D.C., Zhang L., and Li L., Comparison of two dimensional fractionation techniques for shotgun proteomics. Anal Chem., 80, 6715–6723 (2008).
35. Enriquez N., Peltzer M., Raimundi A., Tosi V., and Pollio M.L., Characterization of wheat and quinoa flour in relation to their bread making quality. J Argent. Chem. Soc., 91, 47–54. (2003).
36. Kulp K., and Lorenz K., Handbook of dough fermentations. New York: Marcel Dekker Inc. p 1–21 (2003).
37. Clarke C. I., and Arendt E.K., A review of the application of sourdough technology to wheat bread. Advances in Food and Nutrition Research, 49, 137-161 (2005).
38. Clarke C.I., Schober T.J., and Arendt E.K., Effect of single strain and traditional mixed strain starter cultures on rheological properties of wheat dough and on bread quality. Cereal Chemistry, 79, 640–647 (2002).
39. Tafti A., Mithas S., and Krishnan M. S., The effects of information technology-enabled flexibility on formation and market value of alliances. Management Science, 59 (1), 207-225 (2013).
40. Arendt E. K., Ryan L. A. M., and Dal Bello F., Impact of sourdough on the texture of bread. Food Microbiology, 24, 165–174 (2007).
41. Shadi B., Mohammad H., Haddad K., Gholamali G.M., and Majid A., Effect of lactic fermentation (Lactobacillus Plantarum) on physicochemical, flavor, staling and crust properties of semi volume bread (baguette). World Appl. Sci. J., 8(1), 101-106 (2010).
42. Gomez R., Burns G. L., Walsh J. A., and Moura M. A., A multitrait–multisource confirmatory factor analytic approach to the construct validity of ADHD rating scales. Psychological Assessment, 15, 3-16 (2003).