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The effect of spraying a dry bread yeast suspension and a licorice root extract on cauliflower plant growth and yield (*Brassica oleracea* var. *botrytis*)

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Abstract: The present work is an endeavor to examine the impact of spraying via a suspension of yeast origin and an extract of licorice roots. We focused on three distinct concentrations of (20.10.0) g L^{-1} to investigate their effects on the growth and yield of cauliflower plants. The experiment was conducted in an agricultural station affiliated with the College of Agriculture, University of Basrah, in the Garmat Ali region during the winter agrarian season 2022-2023. The study's findings showed that a spray concentration of 10 g L^{-1} of the dry yeast suspension significantly increased plant height, leaf area, dry weight of the plant, curd diameter, weight, and yield, In contrast a concentration of 20 g L^{-1} significantly increased the total soluble solid (TSS) in the curd. Moreover, the plants sprayed with licorice root extract at a concentration of 10 g L^{-1} showed significant increases in plant height, the number of leaves, leaf area, dry weight, curd diameter and weight, total yield, and the percentage of total soluble solids in the curd. Additionally, the concentration of 20 g L^{-1} significantly increased the chlorophyll and carotene pigments in the leaves.

Keywords: Cauliflower plant, Dry bread yeast suspension, licorice root extract, Yield.

Introduction

Some plants' natural extracts serve as contemporary tools in sustainable agriculture, promoting vegetative growth and boosting crop productivity. These products are nutrient-rich, naturally occurring growth hormones, are environmentally friendly, and have low toxicity (Khalil & Ismael, 2010). One of them is an extract of Glycyrrhiza glabra licorice roots, which is full of minerals like magnesium, phosphorus, iron, manganese, copper, zinc, cobalt, and mevalonic acid. Mevalonic acid helps make gibberellin, which aids cells to divide and grow (Wang *et al*., 2015). Al-Hubaiti & Mohammed (2013) observed that when spraying lettuce plants, *Lactuca sativus* L., Paris Island variety, different concentrations of licorice root extract (3, 1.5, 0) g L^{-1} significantly outweighed the concentration of 3 gm L^{-1} in the fresh stem weight and length of the plant. The control treatment was compared to the stem, dry weight of plant

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leaves, head weight, and total yield. The total chlorophyll content of the leaves was not significantly influenced by the interventions. Sarhan & Mahmood (2021) observed the results of spraying red Cabbage plants, specifically *Brassica oleracea* var. *capitata*. With different concentrations of licorice root extract (7.5, 5, 2.5, 0 g L^{-1}), the reason for the concentration of 5 g L^{-1} is a significant increase in the number of leaves, leaf area, total chlorophyll, head weight, and total yield.

If you spray Organza hybrid cauliflower plants with licorice root extract at concentrations of (14, 7.0) g L^{-1}, as Saleem & Saied (2023) found, it was much better than the high concentration of 14 g L^{-1} at increasing the number of leaves, the dry weight of the leaves, and the content of the leaves. The study also measured the total chlorophyll, curd diameter, total yield, and the percentage of total soluble solids in the curd. Yousif & Saied (2023) showed that spraying broccoli plants with different concentrations of licorice root extract (18, 12, 6, 0) g L^{-1} was significantly superior to the higher concentration of 18 g L^{-1} in increasing one plant's yield and total yield. In recent years, there has been a growing trend towards the use of natural biofertilizers, such as dry bread yeast (*Saccharomyces cerevisiae*), which promotes the growth and productivity of various vegetable crops in a safe, healthy, and pollution-free manner (Daniel *et al*., 2022). This yeast is a rich source of major nutrients, minor plant growth regulators such as auxins and gibberellins, sugars, and vitamins, particularly vitamin B (Medani & Ragab,2015). These biofertilizers play a significant role in enhancing the effectiveness of enzymes, improving nutrient absorption, and stimulating the vegetative growth of the plant(Abou EL-Yazied& Mady,2012) Additionally, yeast releases CO_2 gas, enhancing the efficiency of the photosynthesis process in plants (Al- Shamary & Huthily, 2019).

Abedl-Nabi *et al*., (2020) found that spraying Holland Fargo cauliflower plants with a suspension of bread yeast at a concentration of 100g L^{-1} caused a significant increase in the number of leaves, plant weight, head weight, total yield, and the percentage of dry matter in the leaves and heads. This increase was observed both during the experiment's two seasons and in comparison, to the control treatment. Abou-El-Hassan *et al*., (2021) found that adding 1 kg of dry yeast to a liter of molasses, adding 20 liters of water, and letting it ferment for 12 hours was much more effective than adding the same amount of water to the soil after one week and again after four weeks at a rate of 160 liters per $acre^{-1}$. For red cabbage plants, receiving half the fertilizer recommendation resulted in a significant increase in the number of leaves, head weight, total yield, and percentage of total soluble solids compared to receiving half the fertilizer recommendation for both seasons of the experiment.

Ali & Mutar (2023) found that spraying Kohlrabi (*Brassica oleracea* var. *gongylodes*)plants with yeast suspensions (6, 4, 2, 0) g L^{-1} increased leaf area and dry matter. However, it did not substantially influence plant length or leaf count. The cauliflower plant, *Brassica oleracea* var. *botrytis*, a member of the *Brassicaceae* family, holds significant importance as a winter crop. Its pink pods, rich in vitamins (B_6, B_5, K, C), fiber, folic acid, and mineral elements (P, Mg, Fe, Zn, K) (Al-sudani *et al*., 2025,Kemble *et al*., 2022), make it an excellent source of polyphenolic antioxidants, making it one of the best vegetable crops (Ahmed & Ali ,2013). Due to

the significance of the previous information, we conducted this study to investigate the impact of infusing licorice roots and a suspension of dry bread yeast, as well as their interaction, on the growth and yield of hybrid cauliflower plants in the Basra Governorate.

Materials & Methods

The field experiment was conducted at the College of Agriculture, University of Basra, Garmat Ali site on 10/28/2023, following the Complete Randomized Block Design (RCBD), after preparing the land for planting. The experiment included two factors: the first factor included spraying with three concentrations of dry yeast suspension, which are (0, 10, 20) g L^{-1}, and the second factor was spraying with three concentrations of licorice root extract, which are (0, 10, 20) g L^{-1}. There are nine factorial coefficients in the experiment, and they show how three different concentrations of foliar spraying with a dry yeast suspension and this results in a total of 27 experimental units. The treatments were started one month after planting, three times, and every two weeks between one spraying and another.

Vegetative growth characteristics, such as plant height, number of leaves, leaf area dm2, dry weight of the plant, and total chlorophyll mg 100 gm^{-1} fresh weight, were included in the experimental measurements. Additionally, the diameter of the curd, weight of the curd, total yield, and percentage of dry matter were assessed. The percentage of total soluble solids was recorded in curd. The GenStat

statistical program statistically analyzed the average results and used the Least Significant Differences Test (LSD) test to compare the averages at the 0.05 probability level.

Results &Discussion

Table (2) demonstrated a significant impact of the two factors under study and their interaction on all the studied traits. For example, plants sprayed with a dry yeast suspension at the right concentration 10 g L^{-1} grew taller, had more leaves, and weighed drier than plants given the control treatment. We sprayed at a 20 g L^{-1} concentration, observing an increase rate of (5.16, 3.88%), (17.68, 10.58%), and (29.64, 12.95%), in that order. The increase may be due to the yeast suspension, which contains many nutrients important for plant growth (Medani & Ragab,2015).

As well as its role in increasing enzyme effectiveness, improving nutrient absorption, and stimulating vegetative growth. These results are consistent with what was obtained by (Ali & Mutar 2023, Hassan *et al*., 2023) , on the other hand, both concentrations caused a significant decrease in the number of leaves and the leaf content of chlorophyll and carotene pigments compared to the control treatment, with a decrease rate of (10.22, 10.22) %, (12.72, 7.25) %, (10.62, 5.62) %, respectively. The decrease may be attributed to the role of the bread yeast suspension, at the appropriate concentration for spraying, in increasing the leaf area of the plant, which reduced the intensity of light to which it is exposed, as light plays an important role in the growth and development of plastids, pigments, and the formation of chlorophyll.

The same table shows that spraying with 10 g L^{-1} of licorice roots made the plant's leaf area and dry weight much higher compared to the control treatment and the 20 g $L^{-1}$of licorice roots, with growth rates of (15.51, 7.74) %, (7.68, 11.06) %, respectively. With an increase rate of (2.25%). The concentration of 10 g L^{-1} significantly outperformed the

concentration of 20 g L^{-1} in boosting plant height, while showing no significant difference from the comparison treatment. Also, both concentrations of 10.20 g L^{-1} were significantly superior in the number of leaves, with an increase rate of (4.38, 6.96) %. In comparison to the control treatment, the high concentration of 20 g L^{-1} significantly increased the content of total chlorophyll and carotene pigments in the leaves, with an increase rate of (7.46, 6.62%), (6.04, 8.21) %, and straight increases.

Table (2): The impact of spraying with a suspension of dry bread yeast and an extract of licorice roots, as well as their interaction, on various indicators of vegetative growth and two photosynthetic pigments of cauliflower plants.

Treatments		Plant height (cm)	Total number of leaves (leaf plant^{-1})	Leaves area (dm2)	Dry weight of plant (g)	Total chlorophyll in leaves mg 100 g^{-1} fresh weight	Carotene in leaves mg mg 100 g^{-1} fresh weight
Average effect of dry bread yeast suspension (g L^{-1})	**0**	54.33	19.56	53.74	66.55	8.41	0.160
	10	56.44	17.56	59.43	75.17	7.80	0.151
	20	53.67	17.56	50.50	57.98	7.34	0.143
LSD 0.05		**0.73**	**0.76**	**2.80**	**1.00**	**0.06**	**0.002**
Average effect of licorice extract (g L^{-1})	**0**	55.00	17.56	54.37	63.56	7.70	0.146
	10	55.33	18.78	58.58	70.59	7.64	0.149
	20	54.11	18.33	50.71	65.55	8.21	0.158
LSD 0.05		**0.73**	**0.76**	**2.80**	**1.00**	**0.06**	**0.002**
Interaction between dry yeast suspension and licorice root extract	**0**	0	18.67	50.43	51.30	8.39	0.157
		10	20.00	66.63	71.35	8.04	0.166
		20	20.00	44.15	77.00	8.81	0.157
	10	0	16.00	58.13	80.04	7.82	0.153
		10	18.33	54.62	69.70	7.55	0.140
		20	18.33	65.53	75.76	8.03	0.161
	20	0	18.00	54.55	59.34	6.88	0.130
		10	18.00	54.48	70.72	7.33	0.142
		20	16.67	42.46	43.90	7.80	0.158
LSD 0.05		**1.27**	**1.32**	**4.85**	**1.74**	**0.11**	**0.004**

The extract containing mevalonic acid, the bio initiator in building internal gibberellins (Wang *et al*., 2015), may have contributed to the significant increase in indicators of vegetative growth and the photosynthetic pigments chlorophyll and carotene when spraying with licorice roots. This extract led to an increase in cell elongation, which in turn led to an increase in the shoots. He reported that the extract contains many nutritional elements, including nitrogen, iron, and magnesium, which are involved in the synthesis of the chlorophyll molecule. The extract also contains auxins and cytokinin's that work to encourage physiological activities, delay leaf senescence, and increase chlorophyll, which is responsible for the photosynthesis process (Ghaloom &Faraj, 2012). The obtained results align with the findings of, Sarhan **&** Mohmood (2021), and Saleem & Saeid (2023). The study found that the interaction between two factors significantly impacted all traits, with plants sprayed with a 10 g L^{-1} bread yeast suspension and those not sprayed with a licorice root extract achieving the highest plant height and weight.

The dry number reached (57.67 cm, 80.04 g), respectively, and the plants not sprayed with the yeast suspension and those sprayed with the licorice root extract at two concentrations of 10.20 g L^{-1} gave a greater number of leaves, reaching 20 leaves. The plants not sprayed with the yeast suspension and the ones sprayed with the licorice root extract at the concentration of 10 g L^{-1} gave a higher number of leaves, reaching 20 leaves. Also, plants not sprayed with yeast suspension and those sprayed with licorice root extract with a concentration of 10 g L^{-1} had the largest leaf area of 66.63 cm^2. The plants sprayed with licorice roots at a concentration of 20 g L^{-1} without yeast showed the highest chlorophyll content in their leaves, measuring 8.81 mg per 100 g^{-1} fresh weight Conversely, the plants that were not sprayed with yeast and sprayed with an extract of licorice roots at a concentration of 10 g L^{-1} exhibited the highest content. Carotene in leaves reached 0.166 mg per 100 g^{-1} fresh weight. The lowest values for plant height was 52.33 cm in plants not sprayed with both extracts, and the number of leaves in plants sprayed with a yeast concentration of 10 g L^{-1} and not sprayed with licorice root extract reached 16 leaves, while plants sprayed with yeast at a concentration of 20g L^{-1} and an extract of licorice roots at a concentration of 20g L^{-1} gave the lowest leaf area, which amounted to 42.46 cm2, and the lowest dry weight, which amounted to 43.90 gm. Plants sprayed with yeast at a concentration of 20 g L^{-1} and those not sprayed with licorice root extract had the lowest leaf content of total chlorophyll and carotene, measuring (0.130, 6.88) mg per 100 g^{-1} fresh weight, respectively.

Table (3) indicates that spraying with a suspension of dry bread yeast had a significant effect on all parts of the yield except for the percentage of dry matter in the plant.

This is because the concentrations that were higher than 10 g L^{-1} made curd bigger, it weighed more, and the total yield was higher than with the control treatment. The concentration is 20 g L^{-1}, with an increase rate of (6.26, 4.14) %, (15.08, 15.77) %, and (15.08, 15.77) %, respectively. The control treatment and the 20 g L^{-1} concentration significantly outperformed the 10 g L^{-1} concentration in boosting the percentage of total soluble solids in the plant, Achieving increase rates of 5.18 and 7.88%, respectively. Yeast's positive impact on the characteristics of vegetative growth (plant height, leaf area, and dry weight of the plant) (Table 2) demonstrates its significant superiority by accelerating the production of photosynthesis-related materials, as demonstrated in Researchers (Al- Shamary & Huthily, 2019; Abdl-Nabi *et al*., 2020; Abou-EL-Hassan & Hawash, 2021; Ali & Mutar,2023) have observed a positive impact on the diameter of the floral disc, its weight, and the total yield.

The same table shows that spraying different amounts of licorice root extract had a big impact on all the yield factors that were looked at, except for the dry matter percentage in the plant. For example, spraying 10 grams of licorice root extract per liter of water made the plants taller, with a rate of (1.80 to 8.32) % more than the treatment. The comparison is based on a concentration of 20 gL^{-1}.

Table (3): The impact of spraying with a suspension of dry bread yeast and an extract of licorice roots and their interaction on the yield components of cauliflower plants.

Treatments		curd diameter (cm)	curd weight (kg)	Total yield t ha $^{-1}$	Dry matter content in %plant	Total soluble solids in %plant
Average effect of dry bread yeast suspension gL^{-1}	0	19.53	1.344	36.960	8.83	5.20
	10	20.34	1.556	42.771	9.09	4.82
	20	19.14	1.352	37.198	9.12	5.07
LSD 0.05		0.27	0.12	3.300	NS	0.13
Average effect of licorice extract g L^{-1}	0	18.75	1.332	36.850	8.85	4.64
	10	20.31	1.465	40.287	9.24	5.21
	20	19.95	1.455	40.003	8.95	5.24
LSD 0.05		0.27	0.12	3.300	NS	0.13
Interaction between dry yeast suspension and licorice root extract	0	18.79	1.340	36.850	7.89	4.40
	0	19.74	1.371	37.702	9.33	5.60
	0	20.06	1.321	36.327	9.07	5.60
	10	19.74	1.394	38.335	9.12	4.73
	10	20.91	1.625	44.687	9.31	4.83
	10	20.38	1.647	45.292	8.86	4.90
	20	17.72	1.263	34.732	9.55	4.80
	20	20.27	1.399	38.427	8.88	5.20
	20	19.43	1.396	38.390	8.94	5.23
LSD 0.05		0.48	NS	NS	0.63	0.23

While the two concentrations, 20.10 gL^{-1}, significantly increased the weight of plant, the total yield, and the percentage of total soluble solids in the plant compared to the control treatment, with an increase rate of (9.23, 9.98) %, (9.23, 9.98) %, (12.93, 12.28) % and respectively.

The significant increase could be attributed to the licorice root extract's role in enhancing the plant's vegetative growth indicators, such as the number of leaves, leaf area, and dry weight (Table 2). This, in turn, led to an increase in diameter of curd, its weight, the total yield, and the percentage of total soluble solids. The plant increases the efficiency of the photosynthesis process in plants. These results are consistent with what was obtained by (Al-Hubaiti & Ahmed 2013, Saleem & Saied, 2023; Yousif & Saied, 2023). It appears that the the interaction of the two study factors had a significant effect on the diameter of the flower disc, the percentage of dry matter, and the percentage of substances. The plant contains total soluble solids. The plants that were sprayed with a suspension of bread yeast at a concentration of 10 g L^{-1} and an extract of licorice roots at a concentration of 10 g L^{-1} produced the largest diameter of the curd, measuring 20.91 cm. There was 9.55% more dry matter in the curds from plants that were sprayed with a suspension of bread yeast at a concentration of 20 g L^{-1} but not sprayed with an extract of licorice roots. There were 5.60% more total soluble solids in the plant from plants that were not sprayed with yeast but were sprayed with an extract of licorice roots at a concentration of 20.10 gL^{-1}. The lowest values for the diameter of the flower disc were in the plants sprayed with yeast at a concentration of 20 g L^{-1} and those not sprayed with licorice root extract,

reaching 17.72 cm. The plants not sprayed with both extracts showed the lowest percentages of dry matter and total soluble solids in the discs, which were (4.40 and 7.80) %, respectively.

Conclusion

This study leads us to the conclusion that, in order to produce abundant yields from hybrid day cauliflower plants grown in the Basra Governorate, foliar spraying with a suspension of bread yeast at a concentration of 10 g L^{-1} and an extract of licorice roots at a concentration of 10 g L^{-1} is necessary.

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Contributions of authors

Z.A.A.: Conceptualization, experimental design, data collection, analysis, and drafting the manuscript.

O.A.I.: Assisted in data collection, analysis, and contributed to the manuscript writing.

F.I.O.: Conducted the experimental setup and provided expertise in horticultural practices.

A.A.A.:: Supervised the project, provided feedback on the experimental design, and reviewed the manuscript.

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Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this research.

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تاثير الرش بمعلق خميرة الخبز الجافة ومنقوع جذور عرق السوس في النمو والحاصل لنبات القرنابيط *Brassica oleracea* var. *botrytis*

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المستخلص: اجريت الدراسة في محطة البحوث الزراعية التابعة لكلية الزراعة جامعة البصرة في منطقة كرمة علي خلال الموسم الزراعي الشتوي 2022–2023 لدراسة تأثير الرش بمعلق خميرة الخبز الجافة ومنقوع جذور عرق السوس وبثلاثة تراكيز لكل منها (20,10.0)غم لتر$^{-1}$ و التداخل بينهما في نمو وحاصل نباتات القرنابيط هجين النهار .اظهرت النتائج تفوق تركيز الرش 10 غم لتر$^{-1}$ لمعلق خميرة الخبز الجافة معنويا في زيادة ارتفاع النبات و المساحة الورقية و الوزن الجاف للنبات وقطر القرص الزهري و وزنه و الحاصل و تفوق التركيز 20 غم لتر$^{-1}$ معنويا في النسبة المئوية للمواد الصلبة الذائبة الكلية في الاقراص, كذلك تفوقت النباتات المرشوشة بمنقوع جذور عرق السوس بتركيز 10 غم لتر$^{-1}$ معنويا في زيادة ارتفاع النبات وعدد الاوراق و المساحة الورقية و الوزن الجاف وقطر القرص و وزنه والحاصل الكلي والنسبة المئوية للمواد الصلبة الذائبة الكلية في الاقراص و تفوق التركيز 20 غم لتر$^{-1}$ معنويا في محتوى الاوراق من صبغتي الكلوروفيل و الكاروتين . واظهر التداخل بين العاملين تاثيرا معنويا في الصفات قيد الدراسة باستثناء وزن القرص الزهري والحاصل الكلي.

كلمات مفتاحية: نبات القرنابيط، منقوع جذور عرق السوس، معلق خميرة الخبز الجافة، الحاصل .