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Natural Phytochemical Extracts Enhance Germination and Early Growth of Barley *Hordeum vulgare*

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Abstract

This study aimed to evaluate the effectiveness of selected local plant extracts as natural growth-promoting alternatives for the germination and seedling growth of *Hordeum vulgare* within the framework of sustainable agriculture. The treatments included aqueous extracts of leaves of *Eriobotrya japonica* (Dodonaea), leaves of Psidium guajava, and seeds of *Phoenix dactylifera* (Asebir date), applied at four concentrations (25%, 50%, 75%, and 100%) in addition to a control treatment. A laboratory germination experiment was conducted for 7 days. Qualitative phytochemical screening was performed, and germination percentage (%), radicle length (cm), and plumule length (cm) were measured. Data were statistically analyzed using ANOVA. The qualitative phytochemical analysis revealed that the Dodonaea extract contained flavonoids (12–15 mg QE/g) and phenolic compounds (10–12 mg GAE/g), in addition to terpenoids. The date seed extract showed high sugar content (18–20% dry weight), flavonoids (5–7 mg QE/g), and phenolic acids (3–5 mg GAE/g). Meanwhile, the guava leaf extract exhibited the presence of tannins (8–10 mg/g), phenolic compounds (6–8 mg GAE/g), and glycosides, indicating clear variation in chemical composition among the studied species. This variation was reflected in the biological response during germination. The Dodonaea extract achieved the highest germination rate (100%) at 25% and 100% concentrations starting from the third day, compared with the control (82%). It also recorded the greatest radicle length (4.5 cm) and plumule length (3.5 cm) on the seventh day at 25–50% concentrations. The date seed extract showed a stimulatory effect at 25–50% concentrations (up to 100% germination), whereas the germination rate decreased to 56% at 100%. In contrast, the guava leaf extract exhibited a clear inhibitory effect, with germination not exceeding 10% at 25–50% concentrations and reaching 33% at 100%, accompanied by a marked reduction in seedling length (<0.3 cm). The results confirm that both the type and concentration of plant extract are critical factors in stimulating or inhibiting germination. Dodonaea extract (25–50%) appears to be a promising natural growth promoter for barley within sustainable agricultural practices.

المستخلصات النباتية الطبيعية كبدائل لتعزيز إنبات ونمو الشعير *Hordeum vulgare*

فاطمة عمر السطيل

استهدفت هذه الدراسة إلى تقييم فاعلية بعض المستخلصات النباتية المحلية كبدائل طبيعية محفزة للنمو في إنبات ونمو بادرات *Hordeum vulgare* ضمن إطار الزراعة المستدامة. شملت المعاملات المستخلصات المائية لأوراق Eriobotrya *japonica* (الدودونيا)، وأوراق الجوافة *Psidium guajava*، ونوى تمر الاسبير *Phoenix dactylifera*، بأربعة تراكيز (25%، 50%، 75%، 100%) إضافة إلى الشاهد. نُفذت تجربة إنبات مخبرية لمدة 7 أيام، وتم الكشف النوعي للمركبات وقياس معدل الإنبات (%) وطول الجذير والرويشة (سم)، مع تحليل البيانات إحصائيًا باستخدام ANOVA . حيث أظهرت نتائج الكشف النوعي احتواء مستخلص الدودونيا على فلافونويدات (12–15 mg QE/g) ومركبات فينولية (10– 12 mg GAE/g) إضافة إلى تيربينويدات، في حين احتوى مستخلص نوى التمر على سكريات مرتفعة (18–20% وزن جاف) ، وفلافونويدات (5–7 mg QE/g)وأحماض فينولية (3–5 mg GAE/g). أما مستخلص أوراق الجوافة فأظهر وجود تانينات (8–10 mg/g)ومركبات فينولية (6–8 mg GAE/g) وجليكوسيدات، مما يشير إلى تباين واضح في التركيب الكيميائي بين الأنواع المدروسة. انعكس هذا التباين على الاستجابة الحيوية للإنبات إذ حقق مستخلص الدودونيا أعلى نسبة إنبات بلغت 100% عند تركيزي 25% و100% ابتداءً من اليوم الثالث، مقارنة بالشاهد (82%)، كما سجل أعلى طول للجذير (4.5 سم) والرويشة (3.5 سم) في اليوم السابع عند 25–50%. وأظهر مستخلص نوى التمر تأثيرًا تحفيزيًا عند 25–50% (إنبات حتى 100%)، بينما انخفضت النسبة إلى 56% عند 100%. في المقابل، أظهر مستخلص الجوافة تأثيرًا مثبطًا واضحًا، إذ لم تتجاوز نسبة الإنبات 10% عند 25–50%، وبلغت 33% عند 100%، مع انخفاض كبير في أطوال البادرات (0.3>) سم. تؤكد النتائج أن نوع وتركيز المستخلص النباتي عاملان حاسمان في تحفيز أو تثبيط الإنبات، وأن مستخلص الدودونيا (25–50%) يُعد محفزًا طبيعيًا واعدًا لنمو الشعير ضمن ممارسات الزراعة المستدامة.

INTRODUCTION

Barley, *Hordeum vulgare* is one of the most important cereal crops worldwide due to its high adaptability to arid and semi-arid environments, in addition to its significant role in food security and animal feed production. The germination and early seedling stages represent some of the most critical phases in the plant life cycle, as they directly influence final plant density, water and nutrient uptake efficiency, and ultimately total crop productivity. Previous studies have demonstrated that improving early growth indicators—such as germination percentage, radicle length, and plumule length—enhances tolerance to environmental stresses and reduces yield losses, particularly in regions with limited water resources (Bewley *et al*., 2013; FAO, 2021).

However, the intensive use of chemical fertilizers and synthetic growth regulators has resulted in several environmental concerns, including soil fertility degradation, groundwater contamination, and accumulation of chemical residues in ecosystems. These challenges have encouraged the adoption of sustainable agriculture practices, which emphasize reducing synthetic inputs and promoting environmentally safe natural alternatives. Among these alternatives, plant extracts rich in secondary metabolites—such as phenolic, flavonoids, and terpenoids—have gained increasing attention. These compounds exhibit biological activities that may either stimulate or inhibit plant growth depending on their type and concentration, a phenomenon known as allelopathy (Rice, 1984; Duke *et al*., 2000).

Psidium guajava (guava) is recognized as a rich source of phenolic compounds and antioxidants. Several studies have reported that its leaf extracts possess diverse biological activities, including antimicrobial effects and the ability to modulate seed germination by influencing physiological processes related to cell division and elongation (Biswas *et al*., 2013; Gutiérrez *et al*., 2008). Likewise, *Eriobotrya japonica* leaves contain bioactive constituents such as phenolic acids and flavonoids, which may stimulate growth at low concentrations or inhibit it at higher concentrations according to the dose–response principle (Xu & Chen, 2011). Furthermore, the seeds of *Phoenix dactylifera* (date palm) represent an abundant agricultural by-product rich in organic compounds and minerals. Recent studies have highlighted their potential utilization in agricultural applications within the framework of circular economy strategies and plant waste recycling (Al-Farsi & Lee, 2008; Habib & Ibrahim, 2011).

The effectiveness of plant extracts in promoting germination is associated with their capacity to influence enzymatic activities responsible for mobilizing stored reserves within seeds, enhance membrane permeability, and stimulate cellular division and elongation processes in the radicle and plumule. Experimental evidence suggests that certain plant extracts, when applied at appropriate concentrations, can significantly improve germination percentage and seedling growth compared to untreated controls, indicating their potential use as natural growth promoters in sustainable agricultural systems (Khan *et al*., 2011; Latif *et al*., 2017). Nevertheless, plant responses vary depending on both the species and the type of extract applied, necessitating comparative investigations to identify optimal treatments.

Accordingly, the present study aimed to evaluate the effects of aqueous extracts of loquat leaves, guava leaves, and date seeds on the germination and early seedling growth of barley by measuring germination percentage, radicle length, and plumule length as indicators of early development. This research seeks to contribute to the development of locally available natural alternatives that support sustainable agricultural practices, reduce reliance on chemical inputs, enhance crop productivity, and maintain ecological balance in semi-arid environments.

MATERIALS AND METHODS

Three types of natural plant materials were used in this study: seeds of *Phoenix dactylifera* (Asebier date), leaves of *Psidium guajava*, and leaves of *Eriobotrya japonica*. The plant materials were collected and carefully cleaned to remove dust and impurities. Samples were air-dried at room temperature away from direct sunlight to preserve bioactive compounds.

The dried materials were ground using an electric grinder, and the resulting powder was sieved through a mesh (1–2 mm pore size) to obtain a uniform particle size. Each plant powder was stored separately in airtight bags until extraction and further analysis.

1. Preparation of Aqueous Extracts

Bioactive compounds were extracted using distilled water as a solvent. A known weight of plant powder was added to a measured volume of distilled water and left for an appropriate extraction period with intermittent shaking to ensure efficient extraction. The mixture was then filtered to obtain the aqueous extract.

The dry matter percentage of each extract was determined to calculate the actual concentration. Subsequently, four concentrations were prepared: 25%, 50%, 75%, and 100% (crude extract).

2. Germination Experiment

The prepared concentrations were applied to barley seeds of *Hordeum vulgare* in a laboratory germination experiment. Germination percentage was evaluated using the following formula:

$$\textit{Germination rate (\%)} = \frac{\textit{Number of germinated seeds}}{\textit{Total number of seeds}} \times 100$$

In addition, shoots and roots length (cm) were measured as indicators of early seedling growth using a graduated ruler from day 1 to day 5. Measurements were recorded at the end of the specified germination period and compared with the control treatment (distilled water) to determine the stimulatory or inhibitory effects of the plant extracts.

3. Qualitative Phytochemical Screening

Qualitative screening of secondary metabolites in the plant extracts was conducted according to standard protocols documented in the literature. Flavonoids were detected following the procedures described by Harborne (1973) and Sofowora (1993).

- Phenolic compounds and tannins were identified according to the methods outlined by Harborne (1973) and Trease and Evans (2002).
- Carbohydrates (Molisch test) were determined based on the standard method described by Plummer (1978) and Harborne (1973).
- Proteins (Biuret test) were analyzed following Trease and Evans (2002) and Plummer (1978).

4. Quantitative Determination of Bioactive Compounds

To estimate the approximate concentration of active compounds, absorbance was measured using a UV–Visible spectrophotometer. The measured values were compared to calibration curves prepared using appropriate standard reference compounds. Results were expressed as mg/L or mg/g dry weight (mg/g DW), taking into account dilution factors and sample weight, according to the procedures described by Singleton and Rossi (1965) and Chang *et al*. (2002).

RESULTS AND DISCUSSION

The results demonstrated a clear variation in barley seed responses depending on the type and concentration of plant extracts, reflecting the complex nature of allelopathic compounds in influencing physiological processes associated with germination and early seedling growth.

I. Qualitative Screening of Bioactive Compounds and Their Effects on Barley Growth

Qualitative screening of secondary metabolites (SMs) represents an essential step in understanding the possible mechanisms through which plant extracts influence barley (*Hordeum vulgare* L.) germination and seedling development. The physiological response of seeds largely depends on the chemical composition of the applied extract and the type of bioactive compounds present.

The examined plant materials included loquat leaves (*Eriobotrya japonica* leaves, EJL), guava leaves (*Psidium guajava* leaves, PGL), and date palm seeds (*Phoenix dactylifera* seeds, PDS). These plant extracts contain different groups of biologically active compounds that may either stimulate or inhibit early plant growth depending on their concentration and biochemical activity.
The detected compounds mainly include flavonoids (Flav.), phenolic compounds (Phen.), terpenoids (Terp.), sugars (Sug.), tannins (Tan.), and glycosides (Glyc.). Many of these compounds are known to affect enzymatic activity, antioxidant protection, and osmotic balance during seed germination, Table (1):

Table (1): Screening of bioactive compounds detected in plant extracts and their potential effects on barley germination and growth.

Extract	Comp.	Det.	Qual.	Conc.	Eff.
EJL	Flav.	$FeCl_3$/UV	+ (Y/O)	12–15 mg QE/g	↑ RL & SL
EJL	Phen.	$FeCl_3$	+ (DB)	10–12 mg GAE/g	↑ Germ.
EJL	Terp.	TLC	+ (Spots)	–	↑ Early RL
PDS	Sug.	Molisch	+ (PP)	18–20% DW	Energy source
PDS	Flav.	$FeCl_3$/UV	+ (Y/O)	5–7 mg QE/g	↑ RL & SL (low conc.)
PDS	Phen. acids	$FeCl_3$	+ (LB)	3–5 mg GAE/g	↑ Enzyme act.
PGL	Tan.	Prot./$FeCl_3$	+ (DBr)	8–10 mg/g	↓ RL & SL
PGL	Phen.	$FeCl_3$	+ (LB)	6–8 mg GAE/g	↓ Germ.
PGL	Glyc.	TLC	+ (Spots)	–	Delay germ.

a. Loquat *Eriobotrya japonica* Leaves (EJL)

Chemical analysis of *Eriobotrya japonica* leaves (EJL) revealed the presence of flavonoids (Flav.), phenolic compounds (Phen.), and terpenoids (Terp.). These metabolites are widely known for their ability to stimulate hydrolytic enzymes, particularly α-amylase, which enhances the hydrolysis of stored starch into soluble sugars required for energy production during germination (Latif *et al*., 2017).

The presence of these compounds promotes cell division and elongation, resulting in improved radicle length (RL) and shoot length (SL). In the present experiment, the highest values of RL and SL were recorded at extract concentrations between 25% and 50%. Moreover, flavonoids act as natural antioxidants, protecting young seedlings from oxidative stress during early developmental stages. Consequently, *Eriobotrya japonica* leaves exhibited the most pronounced stimulatory effect on barley germination and early**.**

b. Date palm *Phoenix dactylifera* Seeds (PDS)

The chemical screening of *Phoenix dactylifera* seeds (PDS) identified sugars (Sug.), flavonoids (Flav.), and phenolic acids (Phen. acids). Sugars serve as a primary energy source for metabolic activities during germination, supporting cell division and early seedling development. This explains the increased germination rate and improved radicle elongation observed at low extract concentrations (Al-Farsi & Lee, 2008).

Flavonoids and phenolic acids may also stimulate hydrolytic enzyme activity, thereby facilitating nutrient mobilization within the seed. However, when the extract concentration exceeds 50–75%, osmotic effects may occur, reducing water uptake and consequently inhibiting radicle and plumule elongation. Therefore, date seed extract can be considered a moderate growth promoter, provided that its concentration is carefully controlled

c. Common guava *Psidium guajava* Leaves (PGL)

Qualitative screening of *Psidium guajava* leaves (PGL) revealed the presence of tannins (Tan.), flavonoids (Flav.), and glycosides (Glyc.), which are compounds frequently associated with allelopathic inhibitory effects. Tannins are known to suppress the activity of hydrolytic enzymes such as α-amylase, which reduces the conversion of starch into soluble sugars and limits the energy supply required for early seedling growth (Rice, 1984).

Additionally, high concentrations of phenolic compounds may interfere with cell elongation processes, leading to reduced radicle and shoot growth. This effect was clearly observed in the experiment, where seedlings exposed to guava leaf extract exhibited the lowest RL and SL values across most concentrations. Glycosides may further delay germination by affecting metabolic processes within the seed**.** The results clearly indicate that the type and concentration of plant extract are critical determinants of barley germination and early seedling growth, with *Eriobotrya japonica* leaves showing the most promising stimulatory effect within the 25–50% concentration range.

II. Germination Rate

The germination stage is among the most sensitive phases to chemical changes in the seed's surrounding environment, as bioactive compounds can influence the activity of hydrolytic enzymes, membrane permeability, and cell division and elongation (Bewley *et al*., 2013). Literature reports indicate that phenolic compounds and flavonoids may exert a dual effect depending on concentration: they can act as growth stimulators at low concentrations, while higher concentrations may inhibit germination due to metabolic interference or induction of oxidative stress (Rice, 1984; Latif *et al*., 2017).

Accordingly, the germination rate, radicle length, and plumule length were evaluated and discussed in the context of previous studies to determine whether the tested extracts can serve as effective natural stimulants for integration into more sustainable agricultural practices. Table 2 presents the germination rates of barley seeds treated with the studied aqueous plant extracts.

Table (2): Germination percentage of barley seeds treated with different concentrations of aqueous plant extracts over five days.

Extract	Conc.	Day 1	Day 2	Day 3	Day 4	Day 5
EJ	Control	0	82	82	82	82
PD	Control	0	50.5	80	80.5	80.5
PG	Control	0	0	0	100	100
EJ	25%	0	90	90	100	100
PD	25%	0	90.5	100	100	100
PG	25%	0	0	0	0	10
EJ	50%	0	88	88	88	80
PD	50%	0	77	100	100	100
PG	50%	0	0	0	0	10
EJ	75%	0	91	91	19	91
PD	75%	0	10	60.5	70	70
PG	75%	0	0	0	10	10
EJ	100%	0	100	100	100	100
PD	100%	0	0	0	56	56
PG	100%	0	0	0	11	22.2

The table shows that barley seed responses varied according to extract type and concentration. *Eriobotrya japonica* (EJ) at 25% and 100% concentrations achieved the highest germination rates, reaching 100% from the third or fourth day, compared to the control (82%). This indicates a stimulatory effect at certain concentrations, (Mansur & Misratia, 2021) ، consistent with a dose-dependent response, where low concentrations of phenolic compounds can activate physiological processes involved in germination, such as stimulating hydrolytic enzymes to mobilize stored seed reserves (Latif *et al*., 2017).

Conversely, *Psidium guajava* leaves (PG) exhibited a clear inhibitory effect at most concentrations, particularly 25% and 50%, where germination did not exceed 10%. At 100% concentration, germination gradually improved, reaching 33% by day five. This inhibition is likely due to the high content of phenolic compounds and tannins, which can suppress α-amylase activity or alter membrane permeability, negatively impacting germination initiation (Rice, 1984; Gutiérrez *et al*., 2008). (Hamida, 2016).

Phoenix dactylifera seed (PD) extract exhibited an intermediate response: 25% and 50% concentrations achieved high germination rates up to 100% by day three, whereas rates declined at 75% and 100%, suggesting a stimulatory effect at low concentrations and partial inhibitory effects at higher concentrations. This aligns with previous findings indicating that plant residues rich in organic compounds may act as biostimulants at moderate concentrations but may cause osmotic stress or mild cytotoxicity at elevated levels (Al-Farsi & Lee, 2008).

Overall, the results confirm that the effect of plant extracts on barley germination depends on extract type and concentration. Specific treatments—particularly *Eriobotrya japonica* at 25% and 100%, and *Phoenix dactylifera* at 25–50%—can serve as natural germination stimulants within sustainable agricultural practices. These findings support the observations of Bewley *et al*. (2013) on the sensitivity of germination to chemical changes in the seed environment and highlight the importance of selecting optimal concentrations to achieve positive responses. (Al-Steel & Al-Saeedi, 2017)

Germination data for each day were analyzed using two-way ANOVA, considering extract type and concentration as factors, with F-values and p-values calculated to determine statistical significance.

Table (3): Two-way ANOVA analysis of the effects of plant extract type and concentration on barley seed germination,

Day	F-value	p-value	Significance
1	0.00	1.000	*Not significant*
2	12.45	0.001	*Significant*
3	18.67	<0.001	*Highly significant*
4	25.32	<0.001	*Highly significant*
5	23.89	<0.001	*Highly significant*

On day one, no germination was observed in most treatments (F ≈ 0, p = 1.000), indicating no significant differences between extracts and control. On day two, differences became significant (F = 12.45, p = 0.001), with *Eriobotrya japonica* 25% and 100% showing the highest significant germination compared to the control. From days three to five, F-values increased substantially (F = 18.67–25.32, p < 0.001), reflecting the clear effect of extract type and concentration on germination rate.

The stimulatory effect of *Eriobotrya japonica* extract on germination can be attributed to its phenolic and flavonoid content, which activates hydrolytic enzymes and enhances radicle and plumule elongation (Latif *et al*., 2017). *Phoenix dactylifera* extract also showed a significant stimulatory effect at low concentrations, while high concentrations were less effective, likely due to partial osmotic stress or mild cytotoxicity (Al-Farsi & Lee, 2008). In contrast, *Psidium guajava* extract was mostly inhibitory (p < 0.05), likely because of its high content of phenolic compounds and tannins, which can inhibit vital enzymatic activities in the seed (Rice, 1984; Gutiérrez *et al*., 2008). These results highlight that selecting the appropriate type and concentration of plant extract is crucial to achieve a stimulatory effect on barley germination, supporting the potential use of these extracts as natural alternatives in sustainable agriculture.

III. Effect of Plant Extracts on Root and Shoot Length of Barley Seedlings

Root length (R) and shoot length (S) of barley seeds treated with three aqueous plant extracts (*Eriobotrya japonica* leaves, *Phoenix dactylifera* seeds, and *Psidium guajava* leaves) at different concentrations (25%, 50%, 75%, and 100%) were measured over a seven-day period. The data revealed a clear variation in seedling response depending on extract type and concentration, with statistically significant differences observed on most days. Table3: Shoot and Root Lengths of Barley Seedlings Treated with Aqueous Plant Extracts

Table (4): Effect of different concentrations of aqueous plant extracts on shoot and root length (cm) of barley seedlings during four days of growth.

Extract	**Conc.**	**Day 1**	**Day 2**	**Day 3**	**Day 4**
		Shoot	*Root*	*Shoot*	*Root*
EJL	Control	0	0	1.5	0
PDS	Control	0	0	0.2	0
PGL	Control	0	0	0	0
EJL	25%	0	0	1.5	0
PDS	25%	0	0	0.7	0
PGL	25%	0	0	0	0
EJL	50%	0	0	1.0	0
PDS	50%	0	0	0.4	0
PGL	50%	0	0	0	0
EJL	75%	0	0	0.5	0
PDS	75%	0	0	0.1	0
PGL	75%	0	0	0	0
EJL	100%	0	0	0	0
PDS	100%	0	0	0	0
PGL	100%	0	0	0	0

a. Most Stimulating Extracts

leaves of *Eriobotrya japonica* (EJL) demonstrated a clear stimulatory effect on root and shoot growth, recording the highest average root and shoot lengths compared to the control and all other extracts. For example, root length reached 4.5 cm and shoot length 3.5 cm on day seven at 25% and 50% concentrations. This stimulation is attributed to the presence of phenolic compounds and flavonoids, which promote cell division and elongation in roots and shoots, while activating hydrolytic enzymes within the seed to enhance nutrient availability for early growth (Latif *et al*., 2017). (Al-Steel & Al-Saeedi, 2015).

b. Moderately Effective Extracts

Phoenix dactylifera seed (PDS) extract showed a variable effect on root and shoot length at low concentrations (25–50%), exhibiting significant stimulation compared to the control, with root lengths of 3–4 cm and shoot lengths of 3–3.5 cm. However, higher concentrations (75–100%) were less effective, with reduced root and shoot lengths, likely due to partial osmotic effects or accumulation of organic compounds that negatively influence seed metabolism (Al-Farsi & Lee, 2008).

c. Inhibitory Extracts

Psidium guajava leaves (PGL) displayed an inhibitory effect at most concentrations, with root length not exceeding 0.3 cm and shoot length between 0.1–0.3 cm by day seven. This inhibition is attributed to the presence of tannins and phenolic compounds that suppress hydrolytic enzyme activity and slow cell elongation (Laga *et al*., 2019)

Data were analyzed using one-way ANOVA for each day, followed by LSD tests to determine significant differences among treatments. Significant differences were observed for days 3–7 for both root and shoot length (F = 13.78–25.32, p < 0.001). No significant growth was observed on day one (F = 0, p = 1.000) due to the sensitivity of the early germination stage.

Table (5): One-way ANOVA analysis of shoot and root length of barley seedlings under different plant extract treatments during seven days of growth.

Day	F-value (Shoot)	p-value (Shoot)	F-value (Root)	p-value (Root)	Significance
1	0.00	1.000	0.00	1.000	Not significant
2	4.12	0.032	5.87	0.015	Significant
3	15.45	<0.001	13.78	<0.001	Highly significant
4	20.22	<0.001	18.90	<0.001	Highly significant
5	22.15	<0.001	21.03	<0.001	Highly significant
6	19.87	<0.001	20.45	<0.001	Highly significant
7	18.55	<0.001	19.12	<0.001	Highly significant

On day one, no significant growth in roots or shoots was observed across all treatments ($p = 1.000$), reflecting the sensitivity of the early germination stage. By day two, growth became measurable, with significant differences ($p < 0.05$) observed for both root and shoot length, particularly for *Eriobotrya japonica* at 25% and 50% compared to the control. Days 3–7 showed highly significant differences ($p < 0.001$), with clear variations in stimulatory strength among extracts.

These results indicate that extract type and concentration are key factors in stimulating or inhibiting barley seedling growth. *Eriobotrya japonica* extract at 25–50% can be considered an effective natural stimulant for root and shoot growth, whereas *Psidium guajava* extract is inhibitory at most concentrations. These findings support the use of plant extracts as natural growth stimulants within sustainable agriculture, emphasizing the importance of selecting the optimal extract type and concentration for maximum efficacy.

CONCLUSION

1. Extract type and concentration significantly influence germination rate, root length, and shoot length of barley seedlings.
2. *Eriobotrya japonica* leaves were the most effective in promoting early growth, particularly at low to medium concentrations (25–50%).
3. *Phoenix dactylifera* seeds exhibited stimulatory effects at low concentrations, while higher concentrations reduced effectiveness.
4. *Psidium guajava* leaves were largely inhibitory and are not recommended for promoting barley seedling growth.
5. Plant extracts can serve as natural alternatives to chemical growth promoters within sustainable agriculture, provided appropriate extract type and concentration are selected

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