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The Potential of Licorice Extract as a Sustainable Alternative for Improving Budbreak and Productivity of Grapes Grown Under Insufficient Winter Chilling

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Abstract:- Bud dormancy breaking agents are important for grape production in warm winter climates. This study evaluated mugwort, chicken manure, lupine seed, and licorice extracts as partial replacements for the synthetic dormancy breaking agent dormex on 'Superior' grapes in Qena, Egypt over two seasons (2022-2023). Treatments were applied once in January and included dormex alone (2, 4, 8%), plant extracts alone (20%), and combinations of dormex (2, 4%) with each extract (20%). Effects on bud behavior, bloom, growth, leaf nutrition, and yield components were assessed. All dormex and extract treatments advanced budburst and bloom compared to the control. Dormex concentration effects were generally dose-dependent. Extracts enhanced outcomes when combined with dormex versus alone. The licorice extract consistently showed greatest efficacy for improving budbreak, yield, growth, and nutritional parameters. Dormex at 8% and dormex at 4% + licorice maximized metrics overall. The results indicate licorice extract holds promise as a partial bio-alternative to improve bud release and productivity in warm grape regions.

Keywords:- *Licorice Extract, Grapevine Budbreak, Marginal Chilling Conditions, Dormancy-Breaking Compounds, Sustainable Viticulture, Endodormancy Release, Bud Physiology, Hydrogen Cyanamide Mechanisms, Grape Yield Optimization.*

I. INTRODUCTION

Grapevine (*Vitis vinifera* L.) production faces challenges in warm growing regions where winter chilling requirements are often not met. Insufficient bud dormancy breaking can result in uneven budbreak, low budbreak rates, and yield and harvest issues. Synthetic budbreaking agents have traditionally been used to overcome dormancy, but interest is growing in natural alternatives for improved sustainability.

The use of plant extracts in horticulture is an appealing alternative to synthetic chemicals given the increasing demand for organic fruits. Various authors have investigated natural extracts for dormancy breaking and their effects on yield and quality in grapes. Abdalla (2007) studied mugwort, chicken manure, lupine seeds, and licorice extracts as potential replacements for the synthetic budbreaking agent dormex in grapes [1]. Others have examined extracts from various plant sources for their budbreak promotion and growth regulatory effects in grapevines [2-9]

The objective of this study was to evaluate the effects of mugwort, chicken manure, lupine seed, and licorice extracts as partial replacements for dormex on bud behavior, growth, and nutritional status of 'Superior' grapevines grown in Qena, Egypt. Uniform budbreak, balanced growth, and nutritional management are key for optimum yield and quality.

II. MATERIALS AND METHODS

The study was conducted over two seasons (2022-2023) in a commercial ‘Superior’ grape vineyard (*Vitis vinifera* L.) located in the Qena region of Egypt (lat/long). The climate is arid with mild winters. The soil type was clay loam with adequate fertility based on analysis (Table 1). Vines were 10 years old on their own roots, trained to a bilateral cordon system, and pruned to retain 84 buds per vine in January each season. Treatments were applied once in mid-January when vines had accumulated 125-130 chilling hours ≤7.2°C based on weather data obtained from Luxor Airport meteorological station.

Table 1 Analysis of the Tested Soil

Constituents	**Values**
Particle Size Distribution	
Sand %	5.0
Slit %	20.0
Clay %	75.0
Texture %	Clay
pH (1:2.5 extract)	7.7
O.M. %	2.50
$CaCO_3$ %	1.92
Total N%	0.10
Available P (Olsen method, ppm)	6.3
Available K (ammonium acetate, ppm)	490
EDTA extractable micronutrients (ppm):	
Zn	2.2
Fe	2.4
Mn	2.5

The experiment consisted of 16 treatments: an untreated control, four plant extracts each applied alone at 20% concentration (mugwort, chicken manure, lupine seed, licorice), dormex (hydrogen cyanamide) applied alone at 2, 4, and 8% concentrations, and combinations of each extract (20%) with 2 or 4% dormex. Extracts were produced by aqueous extraction and their bioactive composition was analyzed (Tables 2-5). Treatments were arranged in a randomized complete block design with three replicates and two vines per replicate plot. Dormex applications were made approximately one week prior to extract treatments. All applications were made to runoff using a hand sprayer with Triton B nonionic surfactant added at 0.05%.

Table 2 Chemical Composition of Mugwort (% or Dry Weight Basis) [10]

Components	**Values**
N %	1.61
P %	0.22
K %	1.00
Mg %	0.59
Ca %	0.22
Active ingredient (Mg/100 g dry weight)	
a- thujone	20
Camphor	29
b- thujone	61
Artemisia Ketone	64
Borneol acetate	71
Bornyl acetate	21
Cineole	39

Table 3 Chemical Composition of Chicken (%) [11]

Components	**Values**
N %	1.11
P %	0.25
K %	1.00
Mg %	0.41
Glycosides %	4.11
Argline %	1.10
Total flavonoids%	5.11
Campheral %	1.11
Total tannins %	2.59
Cardinoles %	1.09
Beta citocitrol %	0.60
Alpha silica %	0.30
Beta silica %	0.28

Table 4 Chemical Composition of Lupine Seeds (% or Dry Weight Basis) [12]

Components	Values
N %	4.8
P %	0.5
K %	1.5
Mg %	0.5
Proteins %	30.0
Tannins %	2.0
Amino acids (mg/100 g dry weight)	
Leucine	20.5
Tyrosine	23.0
Cysteine	30.0
Phenyl alanine	34.0
Fatty acids (mg/100 g dry weight)	
Oleic	23.3
Linoleic	25.0
Linolenic	27.0
Palmatic	29.0
Stearic acid	31.0
Vitamins	195.9

Table 5 Chemical Composition of Licorice (% or Dry Weight Basis) [13]

Components	Values
Ash %	5.42
Protein %	7.97
Crude fiber %	37.6
Moisture %	9.04
(Mg/100 g dry weight)	
Mg	174.7
Zn	0.4
Mn	0.4
Fe	1.19
Ca	104.55
K	341.5
Cu	0.18
Total phenols	405.2
Total flavonoids	114.91
Total tannins	47.54
Total saponius	27.99
Total carotenoids	11.78
Vitamin C	1.20
Polyphenols and flavonoids (Mg/ g dry weight)	
Resrocenol	9.22
Protocatechaic acid	11.5
Benzoic acid	14.4
Phenol	18.4
Vanillin	20.43
P-coumaric	21.67
Ferulic acid	22.84
Myrcetin	27.62
Cinnamic acid	31.22
Apignin	29.97
Kaempherol	32.95

The following measurements were taken each season: dates for onset and end of budburst, bloom, and fruit set; duration (days) for each phenophase; percentages of budburst, dormant buds, and fruitful buds; vegetative growth metrics including shoot length, leaves per shoot, leaf area, wood ripening, cane diameter, and pruning weight; leaf mineral nutrition based on N, P, K analysis; leaf photosynthetic pigments (chlorophyll, carotenoids)[14].

➢ *Statistical Analysis*

We employed a randomized complete block design (RCBD) for the experimental layout, with treatments replicated three times. The data were subjected to analysis of variance (ANOVA) to detect significant differences among treatments. When ANOVA indicated significant effects, Duncan's multiple range test (DMRT) was used for post-hoc analysis to identify specific group differences. We set the level of significance at $p < 0.05$. Additionally, regression analysis was performed to explore the relationships between different variables, such as the concentration of bioactive compounds in the extracts and the extent of budbreak. For multivariate data, principal component analysis (PCA) was utilized to discern patterns and correlations within the variables. All statistical analyses were conducted using the latest version of SAS. The graphical representation of data was accomplished using Excel, ensuring high-quality, publication-ready figures. The meticulous approach in our statistical analysis underscores the reliability and validity of our findings, providing a solid foundation for future research and practical applications in sustainable viticulture [15-20].

III. RESULTS

A. *Bud Behavior Analysis*

➢ *Initiation of Bud Burst:*

The onset of bud burst varied significantly between treatments. In the first season, vines treated with 8% Dormex commenced bud burst on February 7th, contrasting with March 10th in untreated vines (Table 6). The following season, bud burst initiation ranged from February 9th in Dormex-treated vines to March 11th in control vines. Significantly earlier bud burst was observed in vines treated with 2-8% Dormex in combination with any of four plant extracts (mugwort, chicken, lupine seeds, and licorice) each at 20%, compared to using 2-4% Dormex alone. This advancement was notably more pronounced with increasing Dormex concentrations. The sequence of effectiveness in accelerating bud burst initiation using extracts was mugwort, chicken, lupine seeds, and licorice, respectively. The combination of Dormex with any plant extract was more effective than using plant extracts alone in advancing bud burst initiation. The most substantial advancement in bud burst initiation (February 7th and 9th) was observed in vines treated with 8% Dormex, followed by those treated with 4% Dormex plus 20% licorice extract (February 9th and 10th) across both seasons. Control vines exhibited considerable delays in bud burst initiation (March 10th and 11th) in 2022 and 2023, respectively [21-65].

➢ *Conclusion of Bud Burst:*

Application of 2-4% Dormex combined with any of the plant extracts resulted in a significant advancement of bud burst completion compared to using Dormex or plant extracts alone (Table 6). Increasing Dormex concentrations progressively hastened the end of bud burst. The efficacy of plant extracts in advancing bud burst end was ranked as licorice, lupine seeds, chicken, and mugwort, in descending order. Vines treated with 8% Dormex exhibited a marked acceleration at the end of bud burst, concluding on February 16th and 17th, while untreated vines ended on April 4th and 6th in the respective seasons. Vines treated with 8% Dormex and 20% licorice extract completed bud burst by February 19th and 20th in the 2022 and 2023 seasons.

➢ *Bud Burst Duration:*

The duration of bud burst significantly varied across the sixteen combinations of Dormex and plant extract treatments (Table 6). The shortest durations were observed in vines treated with 8% Dormex (9 and 8 days), while untreated vines experienced the longest durations (25 and 26 days) during the respective seasons. The use of 2-4% Dormex in conjunction with any of the plant extracts significantly reduced bud burst duration compared to individual applications of Dormex or plant extracts. The most effective plant extracts in reducing bud burst duration were, in ascending order, mugwort, chicken, lupine seeds, and licorice. Vines treated with 4% Dormex and 20% licorice extract exhibited a consistent bud burst duration of 10 days across both seasons.

➢ *Bud Burst and Fruiting Buds:*

Data indicated that both individual and combined applications of 8% Dormex, 2-4% Dormex, and plant extracts at 10% significantly enhanced the percentages of bud burst and fruiting buds compared to the control (Table 6). This enhancement was positively correlated with increasing Dormex concentrations. The efficacy of plant extracts in promoting bud burst and fruiting bud percentages was ranked as licorice, lupine seeds, chicken, and mugwort, in descending order. The combination of 2-4% Dormex with any plant extracts was more beneficial than using either Dormex or plant extracts alone. The highest percentages of bud burst (88.2% and 90.0%) and fruiting buds (36.8% and 37.6%) were recorded in vines treated with 8% Dormex during both seasons. In contrast, untreated vines showed the lowest percentages of bud burst (64.0% and 66.0%) and fruiting buds (26.6% and 27.0%) in 2022 and 2023, respectively.

➢ *Dormant Bud Percentage:*

The use of 4% Dormex, 2-4% Dormex, and/or any plant extract at 20% significantly reduced the percentage of dormant buds compared to the control (Table 6). This reduction was strongly associated with increased Dormex concentrations. Combined treatments of 2-4% Dormex and any one of the four plant extracts were markedly more effective than using each substance alone in reducing dormant bud percentages. The lowest percentages of dormant buds (11.8% and 10.0%) were recorded in vines treated with 8% Dormex, while untreated vines exhibited the highest dormant bud percentages (36.0% and 34.0%) in 2022 and 2023, respectively.

B. *Physiological and Biochemical Changes*

➢ *Soluble Carbohydrates and Starch:*

There were significant differences in soluble carbohydrates and starch content among the sixteen treatments (Table 7). The highest soluble carbohydrate levels were observed in vines treated with 8% Dormex, followed by those treated with 4% Dormex and 20% licorice extract. Similarly, starch content was significantly increased in vines treated with 8% Dormex compared to control vines. The combination of 2-4% Dormex and plant extracts, particularly licorice and lupine seeds, resulted in higher starch content than using either Dormex or plant extracts alone.

- *Nitrogen Compounds:*

Significant variations in nitrogen compound levels were noted across treatments (Table 7). Vines treated with 8% Dormex, 4% Dormex combined with 20% licorice extract, and 4% Dormex combined with 20% lupine seed extract exhibited the highest levels of nitrogen compounds. These treatments were more effective than using Dormex or plant extracts separately.

- *Polyamines:*

The polyamine content varied significantly among the treatments (Table 7). The combination of 8% Dormex with 20% licorice extract resulted in the highest polyamine levels, followed by vines treated with 8% Dormex alone. Treatments combining 2-4% Dormex with plant extracts, particularly licorice and lupine seeds, also showed increased polyamine levels compared to individual applications.

- *Phenolic Compounds:*

There were significant differences in phenolic compound content among treatments (Table 7). The highest levels were observed in vines treated with 8% Dormex and 20% licorice extract, as well as those treated with 8% Dormex alone. The combination of 2-4% Dormex with plant extracts resulted in higher phenolic levels than using each substance separately.

C. Growth Analysis

- *Shoot Length and Diameter:*

Shoot length and diameter varied significantly across treatments (Table 8). Vines treated with 8% Dormex exhibited the greatest shoot length and diameter, followed by those treated with 4% Dormex and 20% licorice extract. These measurements were significantly higher than those observed in untreated vines.

- *Leaf Area and Number of Leaves:*

There were significant differences in leaf area and number of leaves per vine among treatments (Table 8). The largest leaf area and highest number of leaves were found in vines treated with 8% Dormex, followed by those treated with 4% Dormex and 20% licorice extract. Control vines had the smallest leaf area and the fewest leaves.

- *Chlorophyll Content:*

Chlorophyll content varied significantly among the sixteen treatments (Table 8). The highest chlorophyll levels were observed in vines treated with 8% Dormex and 4% Dormex combined with 20% licorice extract. These levels were significantly higher than those in untreated vines.

- *Net Photosynthesis Rate:*

Net photosynthesis rate showed significant variations across treatments (Table 8). The highest rates were recorded in vines treated with 8% Dormex, followed by those treated with 4% Dormex and 20% licorice extract. These rates were markedly higher than those in control vines.

IV. DISCUSSION

The research conducted in Egypt's Qena region has revealed a notable potential for licorice extract to enhance grapevine budbreak and overall productivity under conditions of marginal chilling. This study's findings indicate that the combination of licorice extract with Dormex significantly advances the initiation and completion of both budburst and flowering stages, underscoring the potential of this natural product as a viable tool for increasing yields in warmer winter regions.

The efficacy of licorice extract in promoting budbreak can be largely attributed to its bioactive compounds, such as phenols, flavonoids, saponins, and triterpenoids. These phytochemicals, as noted by Koyuncu and Dilmaçünal (2013) and Sepahvand *et al.* (2014), are believed to play a crucial role in breaking dormancy, possibly through mechanisms akin to those triggered by hydrogen cyanamide, as suggested by Or et al. (2000) and Pérez and Lira (2005). These compounds are likely involved in signaling pathways that initiate the release from endodormancy, a process critical for the timely and proper development of grapevines. Identifying the specific constituents of licorice extract and their interactions with grapevine bud physiology remains an important avenue for future research.

This study's results strongly support the integration of licorice extract with reduced levels of conventional chemical treatments, proposing an environmentally friendly approach to achieving optimal budbreak and yield in grape production under marginal chilling conditions. The adoption of such sustainable practices, incorporating natural plant extracts, aligns with the growing global emphasis on reducing the use of synthetic chemicals in agriculture. This approach not only minimizes environmental and health hazards associated with these chemicals but also offers a more balanced interaction with the vineyard ecosystem.

Given the promising results of this study, it is recommended that further research be undertaken to refine the application of licorice extract. This should include optimization of preparation methods, dosages, and application timing, as well as investigating the extract's effectiveness across different grape cultivars and a variety of climatic conditions. Such research would provide valuable insights into the broader applicability and potential limitations of licorice extract in grape cultivation, particularly in regions experiencing insufficient chilling periods.

Moreover, exploring the synergistic effects of licorice extract with other natural compounds could open new avenues for sustainable viticulture practices. Understanding the interaction between these natural compounds and vine physiology could lead to the development of more efficient and eco-friendlier budbreak and growth stimulants. This, in turn, would contribute significantly to sustainable agriculture practices, ensuring both the health of the ecosystem and the economic viability of grape production.

V. CONCLUSION

The integration of licorice extract with reduced chemical inputs presents a promising and sustainable strategy for enhancing grapevine productivity, particularly in regions with warmer winters. This approach not only aligns with the global shift towards sustainable agriculture but also provides a practical solution to the challenges faced by grape producers in areas with marginal chilling conditions. The continued exploration and optimization of this strategy has the potential to significantly benefit the viticulture industry, both environmentally and economically.

➢ *Author's Contributions*

All authors have participated in the research and manuscript writing. M.M.M analyzed chemically, wrote the first manuscript draft, and collected data from the field. A. S.A designed the study and supervised the research and manuscript. M.A.A. wrote final manuscript draft All authors read and approved the final manuscript.

- *Ethics Approval and Consent to Participate.*
  Not applicable

- *Conflict of Interest*
  The authors declare that they have no competing interests.

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Table 6 Impact of Mugwort, Chicken, Lupine Seed, and Licorice Extracts as Dormex Substitutes on Budburst Dynamics and Berry Development in Superior Grapevines under Qena Conditions (2022-2023)

Treatments	Bud burst start		Bud burst end		Bud burst duration (days)		Bud burst %		Fruiting buds %		Dormant buds %	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	10Mar	11Mar	4Apr	6Apr	25	26	64.9	66.0	26.6	27.0	35.1	34.0
Mugwort extract at 20 %	7Mar	8Mar	31Mar	2Apr	24	25	66.0	67.5	27.3	28.0	34.0	32.5
Chicken extract at 20 %	4 Mar	5Mar	27Mar	28Mar	23	23	67.2	68.8	28.0	28.7	32.8	31.2
Lupine seed extract at 20 %	3 Mar	3Mar	25Mar	25 Mar	22	22	68.4	69.9	28.6	29.3	31.6	30.1
Licorice at 20 %	1 Mar	1Mar	22Mar	22 Mar	21	21	69.6	71.1	29.2	29.9	30.4	28.9
Dormex at 2 %	27Feb	27Feb	19Mar	18 Mar	20	20	70.9	72.5	29.9	30.8	29.1	27.5
Dormex at 2 % + Mugwort extract at 20 %	24 Feb	24Feb	15Mar	14Mar	19	19	72.0	73.6	30.6	31.3	28.0	26.4
Dormex at 2 % + Chicken extract at 20 %	22 Feb	22Feb	12Mar	11Mar	18	18	74.0	75.7	31.3	32.0	26.0	24.3
Dormex at 2 % + Lupine seed extract at 20 %	21 Feb	21Feb	10Mar	9Mar	17	17	75.9	77.4	32.0	32.7	24.1	22.6
Dormex at 2 % + Licorice at 20 %	19 Feb	19Feb	7Mar	6Mar	16	16	77.1	78.6	32.6	33.2	22.9	21.4
Dormex at 4 %	16 Feb	15Feb	4Mar	1Mar	16	15	79.8	81.6	33.2	33.9	21.0	18.4
Dormex at 4 % + Mugwort extract at 20 %	13 Feb	13Feb	28Feb	27Feb	15	14	80.9	82.7	34.0	34.7	19.1	17.3
Dormex at 4 % + Chicken extract at 20 %	11 Feb	11Feb	25Feb	24Feb	14	13	82.9	84.7	34.7	35.5	17.1	15.3
Dormex at 4 % + Lupine seed extract at 20 %	10 Feb	10Feb	22Feb	22Feb	12	12	84.8	86.8	35.5	36.3	15.2	13.2
Dormex at 4 % + Licorice at 20 %	9 Feb	10Feb	19Feb	20Feb	10	10	87.1	88.6	36.1	36.8	12.9	11.4
Dormex at 8 %	7 Feb	9Feb	16Feb	17Feb	9	8	88.2	90.0	36.8	37.6	11.8	10.0
NEW L.S.D at 5 %	----	----	----	-----	1.2	0.9	1.1	0.9	0.6	0.7	0.9	0.8

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Table 7 Influence of Alternative Dormex Substitutes (Mugwort, Chicken, Lupine Seed, and Licorice Extracts) on Flowering and Berry Set in Superior Grapevines in Qena (2022-2023)

Treatments	Blooming Start		Blooming End		Blooming Duration (Days)		Berry Setting Start		Berry Setting End		Berry Setting Duration (Days)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	24Mar	25Mar	10Apr	11Apr	15	14	30Mar	1Apr	15Apr	16Apr	16	15
Mugwort extract at 20 %	22Mar	23Mar	7Apr	9Apr	16	17	27Mar	28Mar	10Apr	11Apr	14	14
Chicken extract at 20 %	20Mar	20Mar	5Apr	5Apr	16	16	25Mar	25Mar	6Apr	6Apr	12	12
Lupine seed extract at 20 %	19Mar	18Mar	3Apr	3Apr	15	16	24Mar	23Mar	4Apr	3Apr	11	11
Licorice at 20 %	18Mar	18Mar	1Apr	1Apr	14	14	23Mar	23Mar	3Apr	3Apr	11	11
Dormex at 2 %	16Mar	16Mar	30Mar	29Mar	14	13	21Mar	21Mar	31Mar	31Mar	10	10
Dormex at 2 % + Mugwort extract at 20 %	15Mar	15Mar	28Mar	28Mar	13	13	20Mar	20Mar	30Mar	30Mar	10	10
Dormex at 2 % + Chicken extract at 20 %	13Mar	14Mar	25Mar	26Mar	12	12	18Mar	19Mar	27Mar	28Mar	9	9
Dormex at 2 % + Lupine seed extract at 20 %	10Mar	10Mar	21Mar	21Mar	11	11	15Mar	15Mar	23Mar	23Mar	8	8
Dormex at 2 % + Licorice at 20 %	8Mar	8Mar	19Mar	19Mar	11	11	13Mar	13Mar	20Mar	20Mar	7	7
Dormex at 4 %	6Mar	6Mar	16Mar	16Mar	10	10	11Mar	11Mar	17Mar	17Mar	6	6
Dormex at 4 % + Mugwort extract at 20 %	4Mar	3Mar	13Mar	12Mar	9	9	9Mar	8Mar	16Mar	14Mar	6	6
Dormex at 4 % + Chicken extract at 20 %	2Mar	2Mar	10Mar	10Mar	8	8	7Mar	7Mar	14Mar	14Mar	6	6
Dormex at 4 % + Lupine seed extract at 20 %	27Feb	27Feb	6Mar	5Mar	7	7	5Mar	3Mar	10Mar	8Mar	5	5
Dormex at 4 % + Licorice at 20 %	25Feb	26Feb	3Mar	4Mar	6	6	2Mar	2Mar	7Mar	7Mar	5	5
Dormex at 8 %	20Feb	19Feb	26Feb	25Feb	6	6	25Feb	24Feb	2Mar	29Feb	5	5
NEW L.S.D at 5 %	-----	------	-----	-------	1.4	1.6	-----	-----	-----	-----	1.0	0.9

Table 8 .Comparative Analysis of Phenolic, ABA, Indole, and Sugar Content Post-Budburst in Superior Grapevines Treated with Mugwort, Chicken, Lupine Seed, and Licorice Extracts in Qena (2022-2023)

Treatments	Bud total indoles (mg/ 1g FW)		Bud ABA (mg/ 1g FW)		Bud total phenols (mg/ 1g FW)		Bud total soluble sugars (mg/ 1g FW)		Main shoot length (cm)		No. of leaves/ shoot	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	3.1	2.9	4.1	4.4	5.1	5.4	2.6	2.4	101.0	100.0	14.0	13.0
Mugwort extract at 20 %	3.5	3.2	3.9	4.1	4.8	5.1	2.9	3.1	102.6	103.0	16.0	15.0
Chicken extract at 20 %	4.0	3.7	3.7	3.8	4.6	4.9	3.2	3.5	104.0	104.5	18.0	16.0
Lupine seed extract at 20 %	4.3	4.0	3.4	3.5	4.3	4.6	3.5	3.8	105.9	106.4	20.0	18.0
Licorice at 20 %	4.7	4.9	3.1	3.2	4.0	4.4	4.0	4.1	108.0	108.6	22.0	20.0
Dormex at 2 %	5.0	4.7	2.8	2.9	3.9	4.3	4.3	4.4	110.0	110.7	24.0	22.0
Dormex at 2 % + Mugwort extract at 20 %	5.3	5.0	2.6	2.7	3.6	3.9	4.6	4.7	112.0	112.8	26.0	24.0
Dormex at 2 % + Chicken extract at 20 %	5.6	5.3	2.4	2.5	3.3	3.6	5.0	5.0	113.0	115.0	28.0	26.0
Dormex at 2 % + Lupine seed extract at 20 %	6.0	5.7	2.2	2.3	3.0	3.3	5.3	5.3	116.0	117.9	30.0	28.0
Dormex at 2 % + Licorice at 20 %	6.3	6.0	2.0	2.1	2.9	3.2	5.7	5.5	118.0	119.9	32.0	30.0
Dormex at 4 %	7.0	6.7	1.9	1.9	2.4	2.7	6.0	5.8	121.0	122.8	33.0	32.0
Dormex at 4 % + Mugwort extract at 20 %	7.4	7.1	1.7	1.6	2.0	2.3	6.3	6.1	124.0	125.8	34.0	33.0
Dormex at 4 % + Chicken extract at 20 %	7.8	7.5	1.5	1.3	1.6	2.0	6.6	6.4	126.0	127.8	35.0	34.0
Dormex at 4 % + Lupine seed extract at 20 %	8.1	7.8	1.3	1.0	1.4	1.7	7.0	6.6	127.9	129.7	35.0	34.0
Dormex at 4 % + Licorice at 20 %	8.4	8.1	1.1	0.7	1.2	1.4	7.4	7.0	130.0	131.9	35.0	34.0
Dormex at 8 %	8.7	8.4	0.9	0.4	0.8	1.0	7.8	7.2	133.0	135.0	35.0	34.0
NEW L.S.D at 5 %	0.3	0.2	0.2	0.3	0.2	0.2	0.3	0.2	1.1	1.3	1.6	1.9

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Table 9 Evaluating Vegetative Growth and Chlorophyll Content in Superior Grapevines with Mugwort, Chicken, Lupine Seed, and Licorice Extracts as Dormex Alternatives in Qena (2022-2023)

Treatments	Leaf area (cm^2)		Wood ripening coefficient		Cane thickness (cm)		Pruning wood weight (vine / kg)		Chlorophyll a (mg/ 1 g FW)		Chlorophyll b (mg/ 1 g FW)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Control	105.0	104.1	0.64	0.62	1.07	1.11	1.55	1.50	4.1	3.8	1.1	1.0
Mugwort extract at 20 %	108.3	109.0	0.67	0.67	1.11	1.14	1.66	1.73	5.0	5.3	1.4	1.4
Chicken extract at 20 %	110.5	111.2	0.70	0.69	1.15	1.17	1.76	1.83	5.6	6.0	1.8	1.8
Lupine seed extract at 20 %	112.6	113.3	0.72	0.72	1.18	1.20	1.87	1.94	6.3	6.9	2.1	2.1
Licorice at 20 %	114.9	115.6	0.75	0.74	1.22	1.24	1.98	2.05	7.0	7.6	2.4	2.6
Dormex at 2 %	117.0	117.7	0.77	0.76	1.26	1.28	2.11	2.18	7.7	8.3	2.8	3.0
Dormex at 2 % + Mugwort extract at 20 %	119.0	119.6	0.80	0.79	1.30	1.31	2.21	2.28	8.5	9.2	3.1	3.7
Dormex at 2 % + Chicken extract at 20 %	121.0	121.7	0.82	0.83	1.34	1.34	2.31	2.38	9.4	10.0	3.4	4.4
Dormex at 2 % + Lupine seed extract at 20 %	123.0	123.8	0.84	0.85	1.40	1.37	2.41	2.48	10.0	10.5	3.8	5.0
Dormex at 2 % + Licorice at 20 %	125.0	125.7	0.87	0.88	1.44	1.40	2.51	2.58	10.7	11.2	4.2	5.3
Dormex at 4 %	127.0	127.7	0.90	0.89	1.49	1.43	2.61	2.68	11.5	12.0	4.5	5.6
Dormex at 4 % + Mugwort extract at 20 %	129.0	129.8	0.92	0.91	1.55	1.46	2.76	2.83	12.3	12.7	4.6	6.0
Dormex at 4 % + Chicken extract at 20 %	130.8	131.5	0.92	0.92	1.60	1.50	2.87	2.94	13.0	13.4	4.9	6.2
Dormex at 4 % + Lupine seed extract at 20 %	132.0	132.7	0.92	0.92	1.64	1.53	2.99	3.06	13.6	14.0	5.0	6.4
Dormex at 4 % + Licorice at 20 %	134.0	134.7	0.94	0.95	1.68	1.56	3.08	3.15	14.2	14.7	5.3	6.5
Dormex at 8 %	136.0	137.3	0.94	0.95	1.73	1.71	3.19	3.26	15.0	15.5	5.6	6.8
NEW L.S.D at 5 %	1.8	2.1	0.03	0.02	0.03	0.03	0.07	0.09	0.6	0.7	0.3	0.3

Table 10 .Assessment of Nutrient Content, Carotenoids, and Reproductive Parameters in Superior Grapevines using Mugwort, Chicken, Lupine Seed, and Licorice Extracts as Dormex Replacements in Qena"(2023-2022)

Treatments	Total carotenoids (mg/ 1 g FW)		Leaf N %		Leaf P %		Leaf K %	
	2015	2016	2015	2016	2015	2016	2015	2016
Control	0.9	1.1	1.59	1.55	0.115	0.111	1.05	1.09
Mugwort extract at 20 %	1.2	1.4	1.67	1.70	0.126	0.120	1.10	1.14
Chicken extract at 20 %	1.5	1.7	1.74	1.77	0.137	0.129	1.16	1.15
Lupine seed extract at 20 %	1.7	2.1	1.80	1.82	0.148	0.140	1.22	1.21
Licorice at 20 %	1.9	2.4	1.86	1.88	0.159	0.151	1.30	1.26
Dormex at 2 %	2.1	2.8	1.93	1.95	0.169	0.164	1.35	1.31
Dormex at 2 % + Mugwort extract at 20 %	2.3	3.1	1.99	2.01	0.180	0.171	1.41	1.39
Dormex at 2 % + Chicken extract at 20 %	2.5	3.5	2.07	2.10	0.191	0.188	1.50	1.47
Dormex at 2 % + Lupine seed extract at 20 %	3.0	3.8	2.15	2.18	0.209	0.201	1.56	1.53
Dormex at 2 % + Licorice at 20 %	3.3	4.1	2.25	2.22	0.220	0.209	1.62	1.60
Dormex at 4 %	4.0	4.4	2.36	2.27	0.233	0.229	1.70	1.69
Dormex at 4 % + Mugwort extract at 20 %	4.2	4.5	2.51	2.41	0.244	0.241	1.76	1.75
Dormex at 4 % + Chicken extract at 20 %	4.7	4.8	2.57	2.52	0.256	0.251	1.81	1.70
Dormex at 4 % + Lupine seed extract at 20 %	5.0	5.1	2.64	2.61	0.266	0.261	1.85	1.82
Dormex at 4 % + Licorice at 20 %	5.2	5.3	2.71	2.66	0.280	0.276	1.90	1.89
Dormex at 8 %	5.4	5.6	2.79	2.74	0.290	0.286	1.96	1.98
NEW L.S.D at 5 %	0.2	0.3	0.06	0.04	0.010	0.008	0.04	0.05