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Review Article

Exploring the Cultural Significance, Medicinal Properties, and Agricultural Practice Achievements of Timiz (*Piper capense*) in Ethiopia

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Abstract

Piper capense, widely known as Timiz, is an important spice from the Piperaceae family, native to East Africa, particularly in Ethiopia's southwestern areas. Traditionally used for a myriad of health issues, Timiz holds a significant place in Ethiopian cuisine, embodying cultural traditions. The plant is distinctive in its morphology, with "timiz" in Amharic indicating its curly form. The flavor profile of Timiz is notably unique, exhibiting a milder and sweeter taste that is reminiscent of cloves and cardamom, which enhances its culinary versatility. Typically, the harvested and dried seed spikes are appreciated for their aromatic properties, which are further enhanced through traditional smoking methods. This review explores the traditional medicinal uses of Timiz, relying on ethnobotanical data that illustrate its employment among various African communities for treating ailments like digestive issues, respiratory infections, and other health problems. The results of research on the collection, conservation of accessions, agronomic practices such as watering frequency and media types, as well as propagation methods, are also highlighted. Furthermore, the review identifies challenges within the value chain, such as a lack of awareness regarding processing methods and quality control, stressing the necessity for improved practices to boost Timiz's marketability. Future directions for research, production, and market integration of Timiz in Ethiopia are also discussed, underscoring the multifaceted significance of this spice in Ethiopian culture and medicine while advocating for sustainable agricultural methods to support its cultivation and conservation.

Keywords

Ethiopia, Future Research Direction, Importance, Piper Capense, Threats, Timiz

1. Introduction

Long pepper or Timiz (*Piper capense*) or, is a member of the Piperaceae family and has been traditionally used to treat various ailments in different regions of Africa [1]. *Piper capense* is In Amharic, it is called "timiz," which refers to its unique curly shape. Similar to korarima (Afromomum corrorima), Long pepper flourishes in both wild and semi-wild environments within the natural forests of southern and southwestern Ethiopia. It is most productive at mid to high altitudes, especially in the Keficho and Dawuro zones, with notable locations such as Bonga, Wushwush, and Waka.

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Additionally, regions in Oromia with comparable climatic conditions also support its growth. As a natural forest crop, Long pepper thrives under 50-63% shade.

Surveys conducted in Ethiopia reveal both cultivated and wild varieties of Long pepper flourishing under the natural forest canopy. This plant is a short shrub that can be adversely affected without proper cultural practices. It should be planted during the rainy season due to significant undergrowth, and mulching or occasional watering is advisable during the dry seasons. While Long pepper grows in shaded areas of natural forests, it tends to extend towards more open spaces. Along with korarima, Long pepper is well-suited for mid-altitude areas like Jimma, Dawuro, and Wolayita. Research indicates optimal growth occurs at altitudes between 500 and 1500 meters, with annual rainfall between 1200-7000 mm and temperatures of 20-35 ℃ [2-4]. Virgin and alluvial soils rich in organic matter are particularly conducive to the cultivation of lowland spices.

In Ethiopia, Long pepper is known by various names across languages, including Turfo or Turifo (Kefigna), Timiz (Amharic), Tunjo or Turfo (Oromifa), Tinja (Dawrigna), and Tonjo (Tigirigna). It is a widely utilized spice in the preparation of 'Wot' and serves as a key ingredient alongside other spices. Locally produced, it not only enhances food flavor but also contributes oils used in beverages and medical applications. The spices is harvested from the wild for medicinal purposes in various parts of Africa, while in Ethiopia, all parts of the plant including flowers, leaves, bark, and roots are gathered for their health benefits. In places like Cameroon, P. capense is utilized to combat cancer [5, 6], while in the Comoro Islands, the aerial parts are traditionally used for ailments like diarrhea and cough [7, 8]. The fruit is recognized for its carminative, diuretic, and stimulant properties, making it a remedy for digestive issues, heart and kidney concerns, and coughs [9]. Additionally, leaves preparations address abdominal disorders, and root extracts serve various medicinal purposes. Notably, smoked Long pepper is aromatic without pungency, appealing even to more sensitive palates [10]. This review aims to summarize the uses of Timiz, its production areas, cultivation technologies, and potential future developments.

2. Body of the Text

2.1. Botanical Description of Timiz

It is a shrubby herb, typically reaching heights of 1-2 meters and occasionally exhibiting a subscandent growth form. Its base is semi-woody, with branches predominantly above ground; stems are smooth. The petiole ranges from 2-6 cm, while the leaf blade is broadly ovate measuring approximately 7-15.5 cm long and 6-14.5 cm wide with an ordate base. The upper leaves may appear obliquely truncate, and the leaf tips are acuminate, featuring 7 to 9 veins originating from the base. Spikes are solitary, leaf-opposed, and the peduncle can be up to 3 cm long, with the rachis being shorter during the flower stage. The flower morphologies exhibit slight protandry, with stamens roughly the same length as filaments and a stigma on a distinct style consisting of two lobes. Drupe characteristics include a globose shape, 4 mm in diameter, and a translucent greenish-white appearance [11].

Source: [12]

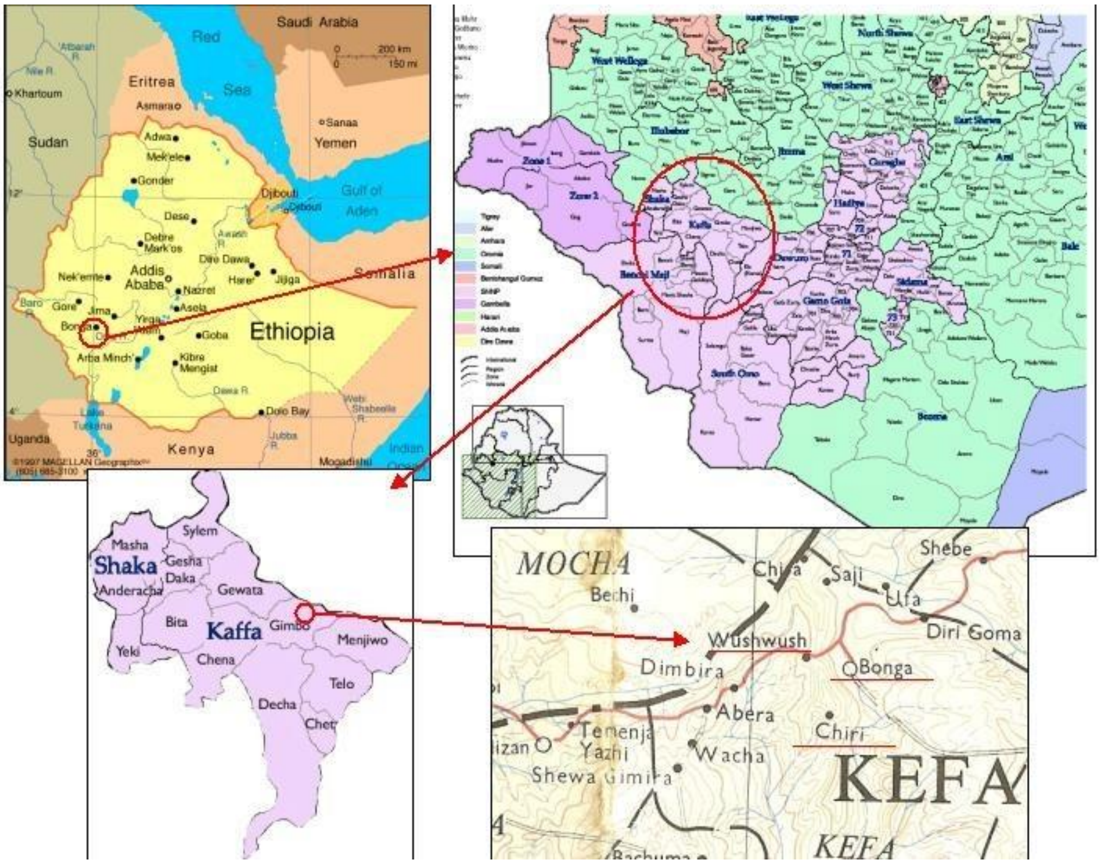
Figure 1. *Botanical description of long pepper.*

2.2. Chemical Composition

Long pepper has lower essential oil content compared to its relatives, measuring about 1%. Analysis reveals that monoterpene hydrocarbons dominate, with β-Pinene and β-Caryophyllene being the most significant compounds. The essential oils are rich in hydrocarbons, constituting over 58%, leading to distinct aroma profiles that cannot be replaced by standard black pepper [13].

2.3. Cultural Significance and How to Use Timiz

Timiz is valued for its versatile application in various dishes, enhancing flavors and complexity. Ethiopian recipes showcase its use, such as in a starter pairing with cheese and a refreshing salad, or incorporated into creamy pasta carbonara, enriching the dish with its smoky essence. It can even elevate dessert experiences, such as in chocolate tarts when paired with raspberries. Beyond culinary benefits, Timiz also possesses therapeutic properties. Piperine increases serotonin, assisting with mood regulation and digestive disorders. Its antibacterial and anti-inflammatory properties support respiratory health, detoxification, and kidney function, while also serving as an aphrodisiac.



Source: [12]

Figure 2. *Area of production and value chain in Ethiopia.*

2.4. Production and Value Chain of Timiz in Ethiopia

Timiz is an indigenous spice crop that is similarly cultivated in natural forests, thriving in the specific climatic and ecological settings of southwestern Ethiopia. However, the value chain remains informal, with challenges in traceability and quality control. Long pepper thrives optimally in the forested regions of mid to high altitudes within the Keficho and Dawuro zones of the Southern region specifically in the Bonga, Wushwush, and Waka areas. Additionally, Jimma and regions with similar climatic conditions are also conducive to long pepper cultivation. Both long pepper and korarima, as forest crops, necessitate a shade level of 50-63% (Figure 2). Upon harvest, farmers trek long distances to urban centers like Addis Ababa for distribution, often resulting in long transport times that could affect quality. Notably, the market pricing remains low due to insufficient processing knowledge and quality issues, suggesting an urgent need for improvements across the value chain to enhance marketability.

2.5. Research Achievements on Long Pepper

The national spices research team in Ethiopia, despite operating with limited resources, has made significant advancements in germplasm enhancement, crop management, post-harvest handling, and quality management in the spice sector. Special emphasis was placed on both lowland and highland seed spices. The performance of many of these spices has shown promising results in terms of yield and quality. Following evaluations, two varieties of black pepper, two varieties of ginger, one cardamom, two turmeric, one vanilla, and two korarima varieties have been successfully released and promoted for their respective agro-ecological zones within the lowland spice category.

2.5.1. Collection and Conservation of Timiz

Ethiopian national spice research has generated several promising results regarding germplasm enhancement and crop management, focusing on lowland and highland spices. Current conservation efforts are increasingly critical due to decreased biodiversity linked to agricultural expansion and environment degradation [14]. Gene banks play a pivotal role in conserving the genetic resources necessary for sustainable agricultural production [15]. Approximately 22 germplasms of Long pepper have been preserved at Choche field gene bank (Table 1), while 20 accessions are currently under evaluation at Tepi Agricultural Research Center (Table 2) [14].

Table 1. Numbers of accessions conserved in the field gene banks.

Field genebank	Size of the area (ha)	Type of species	Type of spice	Number of accessions
Choche	21	Spice	Turmeric	76
			Ginger	178
			Long pepper	22
			Korarima	169
			Pepper	57
			Cardamom	1
			Total	503

Source: [16]

Table 2. Lowland spice accessions and varieties in national spice research.

Common name	Scientific name	Number of accessions	Released Variety
Black pepper	*Piper nigrum* L.	13	Gacheb, Tato
Ginger	*Zingeber officinale Rosc*	92	Yali, Boziab
Cardamom	*Elettaria cardamomum*	3	Gene
Turmeric	*Curcuma domestica*	8	Dame, Tepi-1
Vanilla	*Vanilla planifolia*	4	YEKI-1
Korarima	*Aframomum corrorima*	90	Benchi maji-1, Kefa-1
Long pepper	*Piper capense*	20	Pipelines

Source: [17]

2.5.2. Agronomic Practices Effect on Dry Matter Parameters of Timiz

(i). Shoot Dry Weight (g)

The analysis of variance indicated that the average dry weight of long pepper stem cuttings was significantly influenced by watering frequency, rooting media, and cutting type. The primary effects of both watering frequency and rooting media, as well as their interactions with each other, and the combinations of watering frequency with cutting type and media with cutting type, were all highly significant ($P < 0.01$). Moreover, the three-way interaction among watering frequency, rooting media, and cutting type was also found to be highly significant. Conversely, the main effect of cutting types did not exhibit a statistically significant difference ($p > 0.05$) (Table 3).

Table 3. Analysis of variance for shoot dry weight (g) per cutting of long pepper.

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	18.54	9.27	2.00	0.23	NS
WF	3	156.01	52.01	11.23	0.01	*
Error(a)	6	27.78	4.63	.	.	

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
MEDIA	3	101.48	33.83	19.42	<.0001	*
WF*MEDIA	9	110.26	12.25	7.03	<.0001	*
Error(b)	24	41.81	1.74	.	.	
CUTTING	2	4.13	2.07	0.84	0.44	NS
WF*CUTTING	6	60.47	10.08	4.08	0.002	*
MEDIA*CUTTING	6	46.52	7.75	3.14	0.01	*
WF*MEDIA*CUTTING	18	230.23	12.79	5.18	<.0001	*
Error(c)	64	157.93	2.47	.	.	
Total	143	955.15	.	.	.	

* - Significant at 5% (level of significance opted by user), NS - Non Significant
p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [18]

(ii). Root Dry Weight (g)

The variance analysis of the average dry root weight for long pepper stem cuttings revealed that watering frequency, rooting media, and cutting type significantly influenced the results. Highly significant interactions ($P < 0.01$) were observed between watering frequency and rooting media, between rooting media and cutting type, as well as in the overall combination of watering frequency, rooting media, and cutting type. However, there were no significant differences ($P > 0.05$) found for the main effects of watering frequency, rooting media, or cutting type, nor for the interaction between watering frequency and cutting type (see Table 4).

Table 4. *Analysis of variance for dry root weight per cutting of long pepper.*

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	0.35	0.18	0.26	0.78	NS
WF	3	9.08	3.03	4.44	0.06	NS
Error(a)	6	4.09	0.68	.	.	
MEDIA	3	0.85	0.28	2.61	0.08	NS
WF*MEDIA	9	3.75	0.42	3.83	0.00	*
Error(b)	24	2.61	0.11	.	.	
CUTTING	2	0.45	0.22	1.79	0.18	NS
WF*CUTTING	6	1.27	0.21	1.69	0.14	NS
MEDIA*CUTTING	6	2.34	0.39	3.13	0.01	*
WF*MEDIA*CUTTING	18	11.23	0.62	4.99	<.0001	*
Error(c)	64	7.99	0.13	.	.	
Total	143	44.01	.	.	.	

* - Significant at 5% (level of significance opted by user), NS - Non Significant
p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Souce: [18]

(iii). Root to Shoot Dry Weight Ratio

The root-to-shoot ratio demonstrated a highly significant relationship (p<0.01) that was influenced by the interactions among watering frequency, rooting media, and cutting types. Both the main effect of the rooting media and the interactions between watering frequency and rooting media, as well as rooting media and cutting types, along with the three-way interaction involving all three factors, were all found to be highly significant. Conversely, the main effect of cutting types and the interaction between watering frequency and cutting types did not yield any significant differences (see Table 5).

Table 5. Analysis of variance for root to shoot dry weight ratio per cutting of long pepper.

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	0.02	0.01	1.87	0.23	NS
WF	3	0.05	0.02	3.12	0.11	NS
Error(a)	6	0.03	0.01	.	.	
MEDIA	3	0.02	0.01	6.08	0.00	*
WF*MEDIA	9	0.05	0.01	4.82	0.00	*
Error(b)	24	0.03	0.00	.	.	
CUTTING	2	0.01	0.00	1.38	0.26	NS
WF*CUTTING	6	0.01	0.00	0.99	0.43	NS
MEDIA*CUTTING	6	0.05	0.01	4.14	0.00	*
WF*MEDIA*CUTTING	18	0.17	0.01	4.99	<.0001	*
Error(c)	64	0.12	0.00	.	.	
Total	143	0.55	.	.	.	

* - Significant at 5% (level of significance opted by user), NS - Non Significant

p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [18]

2.5.3. Agronomic Practices Effect on Other Parameters of Timiz

(i). Root Fresh Weight (g)

This study revealed that the fresh weight of roots in long pepper stem cuttings was significantly influenced by the frequency of watering, the type of rooting media, and the cuttings used. Notably, significant differences (P<0.05) were observed in the interactions between the rooting media and cutting type, as well as in the three-way interaction that included watering frequency, rooting media, and cutting type. However, the primary factors watering frequency, rooting media, and cutting type along with their interactions, specifically the combination of watering frequency with rooting media and the interaction between rooting media and cutting type, did not demonstrate significant differences in the fresh weight of the roots in long pepper stem cuttings (Table 6).

Table 6. Analysis of variance for fresh root weight per cutting of long pepper.

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
Rep	2	0.19	0.10	0.75	0.51	NS
WF	3	0.89	0.30	2.25	0.18	NS

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
Error(a)	6	0.79	0.13	.	.	
MEDIA	3	0.19	0.06	1.13	0.36	NS
WF*MEDIA	9	0.52	0.08	1.05	0.43	NS
Error(b)	24	1.32	0.06	.	.	
CUTTING	2	0.03	0.02	0.40	0.67	NS
WF*CUTTING	6	0.28	0.05	1.08	0.39	NS
MEDIA*CUTTING	6	0.65	0.11	2.55	0.03	*
WF*MEDIA*CUTTING	18	1.56	0.09	2.03	0.02	*
Error(c)	64	2.72	0.04	.	.	
Total	143	9.14	.	.	.	

* - Significant at 5% (level of significance opted by user), NS - Non Significant
p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [19]

(ii). Root Number

The analysis of variance revealed a highly significant difference ($P < 0.001$) in the main effects of watering frequency, rooting media, and cutting type. Additionally, significant interactions were observed between watering frequency and rooting media, between watering frequency and cutting type, and in the three-way interaction among watering frequency, rooting media, and cutting type, all concerning the average number of roots per cutting (Table 7).

Table 7. Analysis of variance for root number per cutting of long pepper.

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	5.01	2.51	2.69	0.15	NS
WF	3	159.13	53.04	56.86	<.0001	*
Error(a)	6	5.60	0.93	.	.	
MEDIA	3	73.08	24.36	13.61	<.0001	*
WF*MEDIA	9	64.23	7.14	3.99	0.00	*
Error(b)	24	42.94	1.79	.	.	
CUTTING	2	46.26	23.13	13.01	<.0001	*
WF*CUTTING	6	79.18	13.20	7.42	<.0001	*
MEDIA*CUTTING	6	92.07	15.35	8.63	<.0001	*
WF*MEDIA*CUTTING	18	172.04	9.56	5.38	<.0001	*
Error(c)	64	113.78	1.78	.	.	
Total	143	853.33	.	.	.	

* - Significant at 5% (level of significance opted by user), NS - Non Significant
p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [19]

(iii). Root Length (cm)

The analysis of variance conducted on root length measurements revealed a statistically significant difference ($P < 0.05$) with respect to three key factors: the frequency of watering, the type of rooting media used, and the interaction between watering frequency and the type of cuttings employed. This indicates that variations in these conditions have a notab*le impact on root development.* Conversely, the study did not uncover any significant differences ($P > 0.05$) when examining the interactions that included watering frequency in combination with different rooting media and various types of cutting methods. These results are summarized in Table 8, highlighting the complexities of how rooting conditions influence plant growth and suggesting areas for further research. Overall, while certain factors showed a significant impact on root length, other combinations did not yield the same level of effect, emphasizing the need for targeted exploration in future experiments.

Table 8. *Analysis of variance for root length per cutting of long pepper.*

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	1543.97	771.98	1.98	0.22	NS
WF	3	1615.34	538.45	1.38	0.34	NS
Error(a)	6	2343.02	390.50	.	.	
MEDIA	3	125.77	41.92	0.77	0.52	NS
WF*MEDIA	9	1396.42	155.16	2.84	0.02	*
Error(b)	24	1309.40	54.56	.	.	
CUTTING	2	31.52	15.76	0.54	0.59	NS
WF*CUTTING	6	459.32	76.55	2.60	0.03	*
MEDIA*CUTTING	6	291.48	48.58	1.65	0.15	NS
WF*MEDIA*CUTTING	18	904.48	50.25	1.71	0.06	NS
Error(c)	64	1885.17	29.46	.	.	
Total	143	11905.89	.	.	.	

* - Significant at 5% (level of significance opted by user), NS - Non Significant

p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [19]

(iv). Survival Percent of Cuttings (%)

The analysis of variance (ANOVA) revealed that the survival rate of stem cuttings was significantly influenced by several factors, including watering frequency, the type of rooting media used, and the specific cutting type. Notably, there were significant interaction effects that emerged between various combinations of these factors. Specifically, the interplay between watering frequency and the type of rooting media showed to be impactful, as did the interactions between watering frequency and cutting types, as well as between the types of rooting media and cutting types. Furthermore, a three-way interaction involving watering frequency, rooting media, and cutting types also demonstrated significant effects. In terms of the main effects considered in the study, both the type of rooting media and the cutting type exhibited significant differences in their influence on the survival percentage of the stem cuttings. This suggests that certain combinations of media and cutting types may enhance the likelihood of successful rooting and growth. However, it is worth noting that while the effects of both rooting media and cutting type were significant, the main effect of watering frequency did not yield any statistically significant differences in the survival percentage of the stem cuttings. This finding indicates that varying the frequency of watering alone may not be sufficient to influence the survival outcomes, suggesting that more complex interactions between factors are at play (Table 9). Overall, this analysis highlights the importance of considering multiple factors and their interactions when evaluating the effectiveness of propagation methods for stem cuttings, as these variables collectively contribute to the overall success rate of rooting and establishment.

Table 9. Analysis of variance for percent survival of stem cutting of long pepper.

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	18.89	9.44	0.30	0.75	NS
WF	3	123.69	41.23	1.32	0.35	NS
Error(a)	6	187.99	31.33	.	.	
MEDIA	3	1464.02	488.01	27.29	<.0001	*
WF*MEDIA	9	1523.01	169.22	9.47	<.0001	*
Error(b)	24	429.10	17.88	.	.	
CUTTING	2	5084.50	2542.25	69.26	<.0001	*
WF*CUTTING	6	6076.98	1012.83	27.60	<.0001	*
MEDIA*CUTTING	6	1574.84	262.47	7.15	<.0001	*
WF*MEDIA*CUTTING	18	6040.39	335.58	9.14	<.0001	*
Error(c)	64	2349.03	36.70	.	.	
Total	143	24872.44	.	.	.	

* - Significant at 5% (level of significance opted by user), NS – Non-Significant

p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [19]

(v). Shoot Length (cm)

The growth of new shoots that emerged from stem cuttings was significantly impacted by the interplay of watering frequency, rooting medium, and cutting type, with a statistical significance level of P<0.01. This finding underscores the complexity of these variables, suggesting that their combined effects are essential for optimizing shoot length. Further analysis revealed that not only was the interaction among all three factors crucial, but there were also noteworthy interaction effects occurring between specific pairs of factors. For instance, the interactions between watering frequency and rooting medium, watering frequency and cutting types, as well as between media and cutting types, were all statistically significant. These results indicate that although the main effects of each individual factor watering frequency, rooting medium, and cutting type showed considerable differences in influencing shoot length, it is the interactions between these factors that play a pivotal role in determining the overall growth performance of long pepper cuttings. This complex interplay suggests that careful consideration of how these variables work together is vital for maximizing growth outcomes. Table 10 provides a detailed overview of the significant differences observed in shoot length in relation to these main effects.

Table 10. Analysis of variance for shoot length per cutting of Piper capense.

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	97.72	48.86	0.30	0.75	NS
WF	3	113353.13	37784.38	234.67	<.0001	*
Error(a)	6	966.06	161.01	.	.	
MEDIA	3	28961.02	9653.67	28.15	<.0001	*
WF*MEDIA	9	77686.56	8631.84	25.17	<.0001	*

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
Error(b)	24	8232.00	343.00	.	.	
CUTTING	2	12097.76	6048.88	18.99	<.0001	*
WF*CUTTING	6	74366.68	12394.45	38.92	<.0001	*
MEDIA*CUTTING	6	141836.29	23639.38	74.23	<.0001	*
WF*MEDIA*CUTTIN G	18	72285.71	4015.8	12.61	<.0001	*
Error(c)	64	20380.89	318.45	.	.	
Total	143	550263.83	.	.	.	

* - Significant at 5% (level of significance opted by user), NS Non-Significant p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [20]

(vi). Shoot Girth (mm)

The development of newly sprouted shoots from stem cuttings of long pepper demonstrated a significant impact ($P < 0.01$) from the interplay between watering frequency, the choice of growing media, and the type of cuttings employed. These findings suggest that optimal growth conditions for long pepper stem cuttings can be achieved by carefully considering the interactions among these three factors. In contrast, while the combination of growing media and cutting type did yield effects, these were not significant. Similarly, when examining the individual contributions of each factor watering frequency, rooting media, and cutting variation no notable differences were observed. This indicates that while the holistic approach considering the three factors proved influential, focusing on any single factor or a dyadic combination may not lead to substantial variations in growth outcomes (Table 11). Overall, this research underscores the complexity of plant propagation and highlights the necessity for a balanced consideration of multiple environmental variables to enhance the success rates of long pepper cuttings in various horticultural practices.

Table 11. *Analysis of variance for stem girth of long pepper.*

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	3.53	1.77	3.39	0.10	NS
WF	3	0.71	0.24	0.45	0.73	NS
Error(a)	6	3.12	0.52	.	.	
MEDIA	3	0.02	0.01	0.04	0.99	NS
WF*MEDIA	9	4.11	0.46	3.07	0.01	*
Error(b)	24	3.58	0.15	.	.	
CUTTING	2	0.02	0.01	0.16	0.85	NS
WF*CUTTING	6	1.49	0.25	3.86	0.00	*
MEDIA*CUTTING	6	0.26	0.04	0.67	0.68	NS
WF*MEDIA*CUTTING	18	1.18	0.07	1.02	0.45	NS
Error(c)	64	4.10	0.06	.	.	
Total	143	22.11	.	.	.	

* - Significant at 5% (level of significance opted by user), NS – Non-Significant
p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [20]

(vii). Leaf Number

In this study, we observed a significant impact on the leaf growth of long pepper stem cuttings, with statistical analysis revealing a strong influence of various factors, notably including watering frequency ($P<0.01$). The results indicated that not only did the watering frequency serve as a critical standalone factor, but there were also meaningful interactions at play, particularly the interaction between watering frequency and the type of cutting used. Additionally, our findings highlighted the complexity of plant growth conditions, as interactions that involved the growing media, cutting types, and watering frequency further influenced leaf development. These results suggest that optimizing these factors could enhance the growth potential of long pepper plants. However, it is noteworthy that no significant differences were detected in specific interactions involving watering frequency and media, nor was there a meaningful relationship found between media and cutting types when examined independently. This indicates that while some factors play a pivotal role in growth, others may have negligible effects. The detailed statistical analysis and interaction outcomes are presented in Table 12, which provides further insights into these complex relationships in plant growth dynamics.

Table 12. *Analysis of variance for leaf number per cutting of long pepper.*

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	16.10	8.05	3.09	0.12	NS
WF	3	306.92	102.31	39.29	0.00	*
Error(a)	6	15.63	2.60	.	.	
MEDIA	3	2.31	0.77	0.35	0.79	NS
WF*MEDIA	9	28.08	3.12	1.41	0.24	NS
Error(b)	24	52.94	2.21	.	.	
CUTTING	2	1.68	0.84	0.60	0.55	NS
WF*CUTTING	6	47.38	7.89	5.66	<.0001	*
MEDIA*CUTTING	6	40.15	6.69	4.79	0.00	*
WF*MEDIA*CUTTING	18	167.46	9.30	6.67	<.0001	*
Error(c)	64	89.33	1.40	.	.	
Total	143	767.97	.	.	.	

* - Significant at 5% (level of significance opted by user), NS – Non-Significant

p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [20]

(viii). Leaf Area (cm^2)

The findings of this study regarding the total leaf area revealed intricate and statistically significant interactions among various experimental factors. Specifically, there were highly significant interactions ($P < 0.01$) observed between watering frequency, rooting media, and the types of cuttings utilized. Additionally, significant interactions were noted between watering frequency and rooting media, as well as between watering frequency and cutting type. These results suggest that the effects of watering frequency are modulated by both the type of rooting media and the type of cuttings being used, indicating a complex interplay between these variables that affects the overall leaf area of the plants studied. Conversely, it is worth noting that the main effects of watering frequency, rooting media, and cutting type on their own did not yield statistically significant differences in total leaf area. Additionally, the interaction between rooting media and cutting type was also found to be non-significant. This indicates that, despite the intricate relationships among the variables, the independent effects of each factor and some combinations do not significantly impact leaf area, as presented in Table 13. These insights underscore the importance of considering both individual factors and their interactions to fully understand the dynamics influencing plant growth and morphology. Further research may be needed to explore the underlying mechanisms driving these interactions and to potentially optimize conditions for enhanced leaf area development.

Table 13. Analysis of variance for leaf area (cm) per cutting of long pepper.

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	320.57	160.28	0.22	0.81	NS
WF	3	5055.46	1685.15	2.36	0.17	NS
Error(a)	6	4293.66	715.61	.	.	
MEDIA	3	669.24	223.08	2.40	0.09	NS
WF*MEDIA	9	4091.88	454.65	4.89	0.00	*
Error(b)	24	2231.92	92.99	.	.	
CUTTING	2	21.65	10.82	0.13	0.88	NS
WF*CUTTING	6	4090.94	681.82	7.88	<.0001	*
MEDIA*CUTTING	6	837.13	139.52	1.61	0.16	NS
WF*MEDIA*CUTTING	18	4363.85	242.44	2.80	0.00	*
Error(c)	64	5535.75	86.49	.	.	
Total	143	31512.0474	.	.	.	

* - Significant at 5% (level of significance opted by user), NS - Non Significant
p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [20]

(ix). Shoot Fresh Weight (g)

The analysis of variance (ANOVA) conducted to assess the average fresh shoot weight of stem cuttings revealed that this parameter was significantly influenced by several factors, including watering frequency, rooting media, and cutting type. The results indicated that both the main effects of watering frequency and rooting media, as well as their interaction, exhibited statistically significant differences ($P < 0.05$). This suggests that variations in how frequently the cuttings were watered and the type of rooting media used played crucial roles in determining the average fresh shoot weight. Furthermore, the analysis highlighted a significant interaction among all three variables: watering frequency, rooting media, and cutting type ($P < 0.05$). This finding points to the complexity of the relationships between these factors, indicating that the combined effects of watering frequency and rooting media differ based on the type of cutting used. On the other hand, the main effect of cutting type alone, as well as the interactions between cutting type with both watering frequency and rooting media, did not show significant differences regarding the average fresh shoot weight of long pepper stem cuttings (Table 14). This suggests that while the type of cutting may have some influence, it did not produce statistically significant variations in average fresh shoot weight compared to the marked effects observed with watering frequency and rooting media. Overall, these findings underscore the importance of optimizing both watering frequency and rooting media to enhance the growth potential of stem cuttings, while also suggesting that the specific type of cutting may be less critical in the context of average fresh shoot weight.

Table 14. Analysis of variance for shoot fresh weight (g) per cutting of long pepper.

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
rep	2	5991.61	2995.80	3.13	0.11	NS
WF	3	21196.75	7065.58	7.37	0.02	*
Error(a)	6	5749.57	958.26	.	.	
MEDIA	3	7887.30	2629.10	4.14	0.02	*

Source	DF	Sum of Squares	Mean Square	F-Ratio	p-Value	Significant
WF*MEDIA	9	18315.31	2035.03	3.20	0.01	*
Error(b)	24	15242.91	635.12	.	.	
CUTTING	2	1203.98	601.99	0.96	0.39	NS
WF*CUTTING	6	6554.76	1092.46	1.75	0.12	NS
MEDIA*CUTTING	6	5766.66	961.11	1.54	0.18	NS
WF*MEDIA*CUTTIN G	18	22924.54	1273.59	2.04	0.02	*
Error(c)	64	39953.37	624.27	.	.	
Total	143	150786.74	.	.	.	

* - Significant at 5% (level of significance opted by user), NS – Non-Significant

p-Value < 0.05 - Significant at 5%, p-Value < 0.01 - Significant at 1%

Source: [20]

2.6. Shade Requirement and Management

Shade plays a crucial role in the cultivation and production of economically significant spices, including cardamom (*Elettaria cardamomum M.*), korarima (*Aframomum corrorima* Braun Jansen), and long pepper (Piper capense and Piper umbellatum). Black pepper (*Piper nigrum* L.) can also benefit from shaded conditions, particularly under specific circumstances. The provision of shade not only aids in the growth of these spices but also contributes to their quality and yield, making it an essential component of their cultivation [2, 4, 21, 22]. Common species of shade trees, such as those from the Albizzia, Milletia, and Gravellia genera, are particularly effective in creating the ideal shaded environment needed for cardamom, korarima, and long pepper. These shade trees help maintain an optimal microclimate by regulating moisture levels and temperature variations, which are critical for the healthy development of these spice plants [21]. In Ethiopia, long pepper, specifically Piper capense, holds significant cultural and economic importance. This indigenous spice is traditionally grown in the natural forests of the southwestern region, where it thrives under the protection of surrounding trees. Field studies have shown that long pepper requires a minimum of 50% shade in its native habitat. Classified as a support-obligate vine crop, it relies on surrounding vegetation for physical support and shade, which are integral to its growth [2-4]. Furthermore, during periods of unexpected and extended dry seasons, the shade provided by support trees becomes particularly valuable for black pepper cultivation. Research conducted at the Tepi Agricultural Research Centre has demonstrated that *Erythrina indica* can serve as an effective support and shade tree for black pepper, particularly under intensive management practices [21]. Maintaining an appropriate level of shade is essential for optimal spice cultivation. This requires careful management practices, including strategic pruning to control excess shade and the selection of shade species that retain their foliage throughout the seasons. Additionally, an important cultural practice involves under-planting with additional shade plants whenever the initial shade becomes insufficient. However, it is crucial to strike a balance when it comes to shade levels. Excessive shading, especially beyond the recommended thresholds, can have detrimental effects on flowering, pollination, fruit set, and the overall maturity of most spice species. Therefore, careful monitoring and management of shade levels are vital for sustaining production and ensuring the health of these economically important crops

3. Future Prospects of Timiz Production

Piper capense, commonly known as Timiz in Ethiopia, is a significant native spice that plays a vital role in the country's culinary traditions and agricultural practices. Recognizing the importance of this spice, there is an urgent need for enhanced efforts in germplasm preservation, spearheaded by a collaborative initiative between the Ethiopian Biodiversity Institute (EBI) and the Tepi Agricultural Research Center (TARC). To fully harness the potential of Piper capense, a comprehensive approach that includes extensive research and development needs to be undertaken. This includes the formulation of effective recommendations concerning various aspects of cultivation and processing. Key areas of focus will encompass variety development, which seeks to improve the genetic diversity and resilience of Timiz crops, thereby ensuring sustainable production. In addition, the implementation of advanced agronomic techniques will be crucial. This entails optimizing planting practices, soil management, and irrigation methods to enhance yield and quality. Moreover, integrated pest management strategies need to be devised to minimize the impact of pests and diseases while safeguarding the environment. Furthermore, the development of efficient harvesting and post-harvest handling techniques cannot be overlooked. Proper harvesting methods will ensure that the spice is collected at its peak quality, while effective post-harvest practices will reduce waste and preserve the vital flavors and nutrients of Timiz. Lastly, innovative storage practices will be essential to extend the shelf life of the spice and maintain its quality during distribution. Through a dedicated and collaborative research effort, it is anticipated that these initiatives will not only maximize the potential of Piper capense in Ethiopia but also contribute to the enhancement of local livelihoods, food security, and the preservation of Ethiopia's rich biodiversity. By prioritizing the sustainable development of Timiz, Ethiopia can further establish itself as a key player in the global spice market.

4. Conclusion

Timiz holds an esteemed position within Ethiopian culture, serving not only as a source of exquisite flavors but also as a key component of traditional health practices. This unique spice, known for its robust and distinct taste, offers a plethora of health benefits that are deeply ingrained in local customs and culinary traditions. Its significance goes beyond flavor; it embodies the rich agricultural practices that have been handed down through generations. Timiz thrives in specific environmental conditions, making it essential to protect its genetic diversity to ensure its ongoing viability. This spice's adaptability and resilience are hallmarks of its importance in Ethiopian agriculture. Therefore, advancing cultivation techniques to optimize its growth will be crucial for maintaining sustainable production. By investing in research and development, stakeholders can identify best practices that nurture this crop while preserving its unique qualities. In addition to enhancing cultivation methods, it is imperative to strengthen quality control measures throughout the entire supply chain. By establishing rigorous standards, producers can significantly improve the marketability of timiz, allowing it to retain its esteemed place in Ethiopian cuisine. This not only promotes cultural identity but also contributes to food security, as local producers will be better equipped to meet both domestic and international demands. Moreover, strengthening these processes can stimulate economic growth, providing opportunities for farmers and businesses alike. By recognizing and addressing these challenges, stakeholders can effectively promote and preserve timiz as a culturally significant spice, ensuring that it continues to enrich Ethiopian culinary heritage for future generations. In doing so, they will safeguard not just a beloved spice, but also the cultural narratives and agricultural practices that surround it.

Abbreviations

DF	Degree of Freedom
EBI	Ethiopian Biodiversity Institute
TARC	Tepi Agricultural Research Center
WF	Watering Frequency

Author Contributions

Mohammedsani Zakir Shehasen is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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