Assessment of The Impact of Natural Farming Practices on The Biochemical Composition of *Mangifera indica* L. var. Kesar fruit: A Comprehensive Analysis

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***Abstract* - A field study with Amritjal and Ghanamrit application in mango var. kesar was carried out on 10 years old mango var. kesar trees at Ahmedabad during 2022-23 and 2023-24 seasons. The objective is to study the effect of natural formulations like Amritjal and Ghanamrit on biochemical parameters of the fruits. Amritjal and Ghanamrit are liquid and solid manure respectively with healthy microbial load used in natural farming prepared from cow urine and cow dung. The research addresses the growing reliance on chemical fertilizers in farming, which poses significant risks to environmental health and quality of crop. Results indicates that natural treatments substantially enhance key parameters, such as protein, moisture and vitamin C levels. In contrast conventional method of farming with chemical fertilizers initial benefits in nutrient content but fail to sustain with a time. Overall, the findings of this research highlight the advantages of adopting natural farming practices to improve the quality of mango fruit while promoting sustainable farming methods.**

Keywords: Agriculture, Mango farming, Natural formulations, Biochemical Parameters

1. INTRODUCTION

Mango recognized as the most significant commercially cultivated fruit globally, is believed to have originated in South East Asia and is now grown in approximately 110 countries. Asia accounts for substantial 77% of the world's mango production (Yadav et al., 2016). Mango is also revered as the king of fruits in India. Farmers mainly dependent on chemical fertilizers for the better crop productivity but it possesses serious risk to environment health and soil integrity. Also prolonged use of such chemical fertilizers can decrease soil quality and also adversely affect biochemical properties and edibility of the fruits (Shimbo et al., 2001).

Additionally, the escalating costs of inorganic fertilizer have rendered them increasingly inaccessible to small and marginal farmers. The looming scarcity of certain fertilizer components particularly phosphorus further exacerbates this issue highlighting an urgent need for alternative nutrient sources that are ecofriendly, cost effective, locally adaptable and also sustainable.

Therefore, it is essential to investigate whether the application of nature farming practices such as Amritjal and Ghanamrit prepared from the jaggery, cow dung and cow urine - can effectively substitute inorganic fertilizers without compromising the nutritional quality of mangoes. This

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study aims to evaluate the impact of this nature farming practices on the biochemical parameters of mango fruits of the kesar variety. The objective of this study is to evaluate the impact of bio formulations based on Natural farming, specifically Amritjal and Ghanamrit, on mango fruit quality.

2. EXPERIMENTAL DESIGN

The experimental design implemented in this study is a split plot design characterized by three applications and the incorporation of two factors. The primary factor under investigation pertains to the application of various soil amendments, which were systematically evaluated for their effects on targeted outcomes. The secondary factor involves the temporal aspect of this application, allowing for comprehensive analysis of how time influencer efficacy of each treatment. Each subplot is meticulously delineated measuring 8 × 8 square feet with an intentional buffer zone of two feet maintained between subplots. This special arrangement is designed to mitigate potential interference among treatments thereby any single reliability and validity of the results obtained from this rigorous experimental framework.

3. MATERIAL AND METHODS

In this experiment 10 years old mango trees were selected to evaluate the effects of various treatments including chemical fertilizers, Ghanamrit and Amritjal. The preparations of both formulations was done using the method explained by Kumar et al. in 2023. The Amritjal was applied at a standard concentration of 1:20, while ghanamrit was administered at the rate of 25 kilograms per tree every month through soil application. The specific treatment includes:

T0 (Control)

T1 (Conventional method of farming based on chemical fertilizers and pesticides)

T2 (Ghanamrit)

T3 (Amritjal)

T4 (Combination of both Ghanamrit and Amritjal)

Upon reaching maturity the semi ripe fruits were harvested using harvester pole from the trees. After that, seven days' post-harvest the fruits were carefully brought to the laboratory for the analysis. They were thoroughly cleaned by rinsing in water, air dried under a fan for 10 to 15 minutes and then stored under ambient condition (30 ± 5°C and 60 ± 5 % relative humidity). Various biochemical attributes of the fruits were assessed.

The proximate constituents of the samples, including moisture content, protein content, fat content, ash content and the crude fiber along with titrable acidity and vitamin C content were assessed following standard methods established by the AOAC 2000. Total soluble solids for measured using a Hand refractometer. Also the sugar content in the fruits was determined using the Lane and Eynon method explained by Santini et al., 1953, while Vitamin E and Calcium contains were quantified according to methods outlined by Rosenberg HR (1992) and Vogel (1961) respectively.

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The total energy value of a fruit is calculated by multiplying carbohydrates (4 kcal/g), proteins (4 kcal/g), and fats (9 kcal/g), with carbohydrate content subtracting fat, moisture, protein and ash percentages from 100%. This method proposed by Suksathan et al., (2021) provides a standardized approach to estimating the caloric content of food items.

4. RESULTS AND DISCUSSION

Cultivation practices can significantly influence the chemical composition of the fruits, resulting in noticeable variations in their contents. This variability can occur even among similar varieties, indicating that factors such as soil quality, fertilization methods, irrigation techniques and pest management strategy all play a crucial role in a determining the nutritional and chemical profiles of the fruit produced. As highlighted by Sturm et al., (2003) and Lee et al., (2003), understanding these influences is essential for optimizing fruit quality and ensuring consistency across different growing conditions.

Total Soluble Solids and Titrable Acidity

Total soluble solids values were found very significantly in mango fruits grown under chemical fertilizers based farming and natural farming using various bio cultures. In the first year of the study fruits of plants treated with T4 exhibited the highest TSS content at 14.24 Brix, while the control group (T0) and T1 treatment recorded lower TSS levels of 8.2 and 9.2 Brix respectively. In the second year, T1 experienced a notable decrease in TSS, whereas T0 showed minimum changes. In contrast, all natural treatments (T2, T3, and T4) demonstrated significant increases in TSS, suggesting that natural treatments may have a cumulative positive effect on sugar development overtime resulting in higher TSS levels. Similar findings have been noticed by Andrews et al., (2001) and Reganold et al., (2001) in Apple grown without fertilizers and chemical pesticides.

Conversely, titrable acidity measurements indicated that fruits subjected to chemical treatment (T1) had higher acidity levels at 1.3 compared to those treated naturally (T2, T3, T4). This finding suggests that chemical treatments may contribute to a more acidic fruit profile. In the second year, natural treatments (T2, T3, and T4) showed a decrease in acidity levels while both control (T0) and chemical treatment (T1) exhibited an increase. This shift indicates a reduction in sourness, associated with natural treatments overtime. In study by Ngereza et al., (2016), it was found that titrable acidity was 6.3% higher in conventionally grown Pineapple than naturally grown pineapple.

The analysis of the TSS to titrable acidity ratio in mango pulp over two years highlights the impact of various treatments on fruit quality. In year 1, the control treatment (T0) had a low ratio of 6.3, while T1 showed a slightly better ratio of 7.7. Natural treatments significantly outperformed this with T2 at 13.42 and T3 and T4 reaching ratios of 28.22 and 28.42 respectively. In year 2, the ratios for both control at 5.9 and chemical treatment (T1 at 5.0) declined, indicating a deterioration in flavor balance. Conversely, natural treatment improved further, with T2 increasing to 16.26 and T3 and T4 reaching higher ratios of 40 and 40.77 respectively. In conclusion, the natural treatments can be advantages for improving the flavor profile of mango pulp in agriculture practices.

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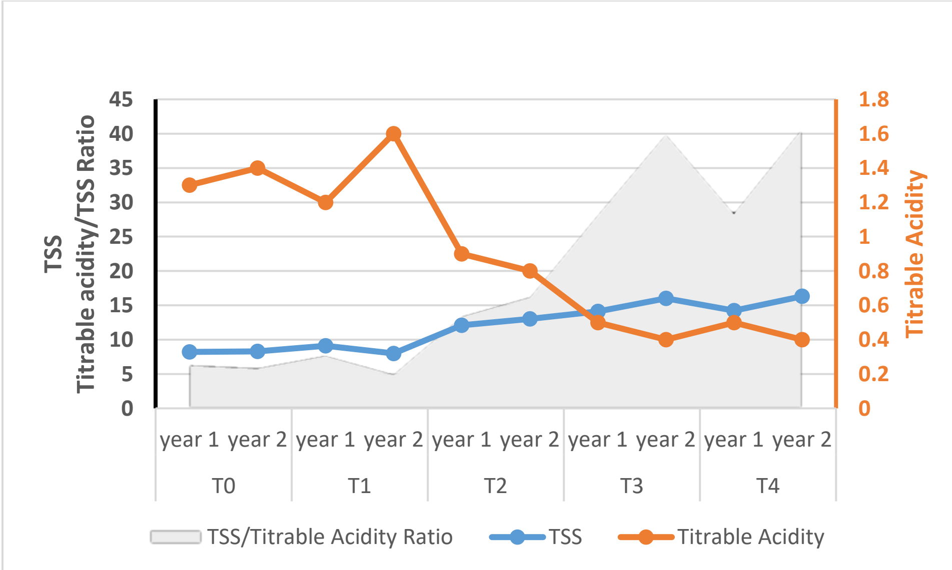

Figure 1: Analysis of Total soluble solids (TSS) expressed in Brix and Titrable acidity (TA) expressed as percentage (%) in Mango fruit under various treatments over Two years. Treatments include T0 (Control), T1 (Conventional), T2 (Ghanamrit), T3 (Amritjal), and T4 (Combination of Ghanamrit and Amritjal)

The proximate analysis

Moisture

The moisture content of mango pulp varies significantly across all treatments over two years. In control treatment (T0) increased moisture level from 74% in year 1 to 80% in year 2, while the chemical fertilizers based treatment (T1) 80% in year 1, increasing to 83% in year 2. On other hand all natural treatments showed lower moisture retention solid (T2) treatment decreased from 73% to 70%, liquid (T3) treatment decrease from 70% to 65% and T4 treatment decrease from 62% to 60%. Several researchers have found that crops cultivated without chemical inputs, exhibit low moisture content compared to those grown with chemical fertilizers and pesticides. This trend was documented by Dhiman et al., (2019) for broccoli.

Ash content

The ash content of mango pulp varied across all treatments over two years, with the control treatment (T0) showing low levels of 0.14% in year 1 and decreasing 0.12% in year 2. The T1 treatment had a higher ash content of 0.92% in year 1 which decreased 0.86% in year 2 indicating a decline over time. Natural treatments showed more stability in which T2 increased from 0.68% to 0.70%, T3 from 0.78% to 0.84% and T4 from 0.80% to 0.82%. In conclusion liquid manure treatment show good result for ash content in mango pulp. Chaudhary et al., (2018) observed that kale grown with chemical input had a lower ash content compared to kale cultivated without the use of chemical pesticides and fertilizers. Similarly, Dhiman et al., (2019) reported analogous result in properly indicating a consistent trend across different groups regarding the impact of chemical farming practices on ash content.

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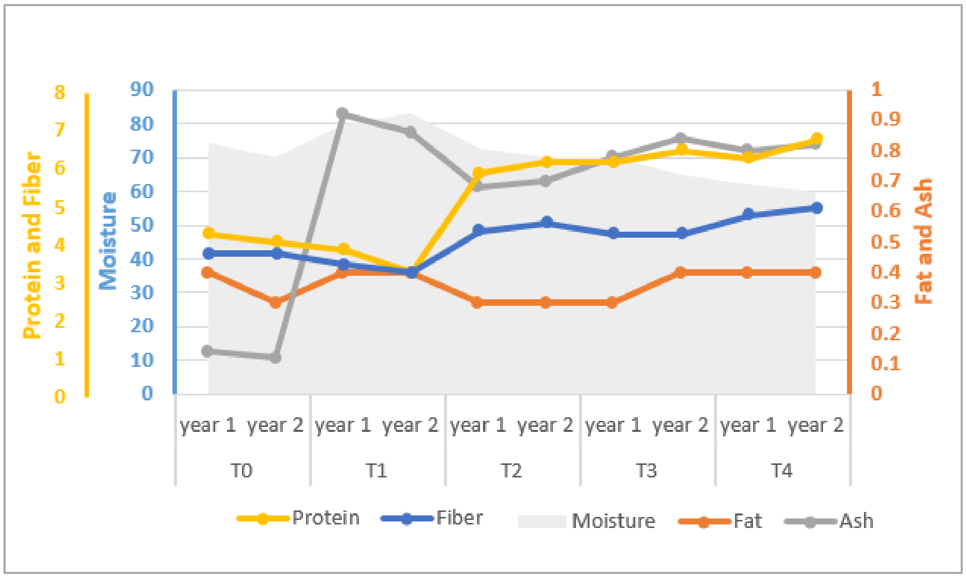

Figure 2: Percentage composition of proximate parameters for mango fruit under various treatments.

Protein

The Protein content of mango pulp vary among all treatments in both years. In year 1, control treatment T0 showed protein content of 4.2% which decrease slightly in year 2 to 4.0%. the chemical treatment T1 showed the lowest protein content of 3.8% in year 1 and dropped to 3.2% in year 2 which indicating a negative impact on protein retention by chemicals fertilizers. In contrast natural treatments showed higher and increasing protein levels with time: T2 from 5.8% to 6.1%, T3 from 6.1% to 6.4% and T4 from 6.2% to 6.7%. These findings suggest that natural treatments particularly T4, combination of both liquid and solid treatments showed positively impact on protein content in mango compared to chemical treatments and controls, highlighting their potential for improving the nutritional quality of fruit. Biological formulations also may be attributed to better filling of fruits due to more balanced uptake of nutrients. Biological formulations may contribute to improve foot filling due to a more balanced agent uptake, which can enhance metabolic activities within the plant this ultimately leads to increased protein synthesis in plants similar results observed by Chenna et al., (2018) in Sapota, Kumar et al., (2019) in pomegranate, and Kundu et al., (2011) in mango.

Fat

The fat content of mango pulp remained low across all treatments over two years, reflecting the fruit is naturally low fat profile. In year 1, the control treatment (T0) had a fat content of 0.4%, which decreased to 0.3% in year 2. The chemical treatment T1 maintained a consistent fat level of 0.4% in both years. Among the natural treatments, T2 and T3 treatment both recorded a fat content of 0.3% in year 1, with T3 increasing to 0.4% in year 2, while T4 remained steady at 0.4%. Overall,

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the results indicate that there are no significant differences in fat content due to treatments, as mangoes are inherently low in fat (Priyanka et al., 2021).

Fiber

The fiber content of mango fruit varied across all treatments over Two years, with the control treatment (T0) maintaining a consistent level of 3.7% in both years. The chemical treatment T1 had a lowest fiber content of 3.4% in year 1, which decreased to 3.2% in year 2. In contrast, all natural treatments showed higher fiber levels: T2 increased from 4.3% to 4.5%, T3 consistent fiber content in both years of 4.2%, and T4 from 4.7% to 4.9%. these results suggest that while chemical treatments may provide a higher initial fiber content, they do not significantly outperform the control over time, whereas natural treatments consistently exhibit lower fiber levels. Chaudhary et al., (2018) indicated that kale grown without chemicals has a higher fiber content compared to kale cultivated through conventional method based on chemicals.

Total Sugars

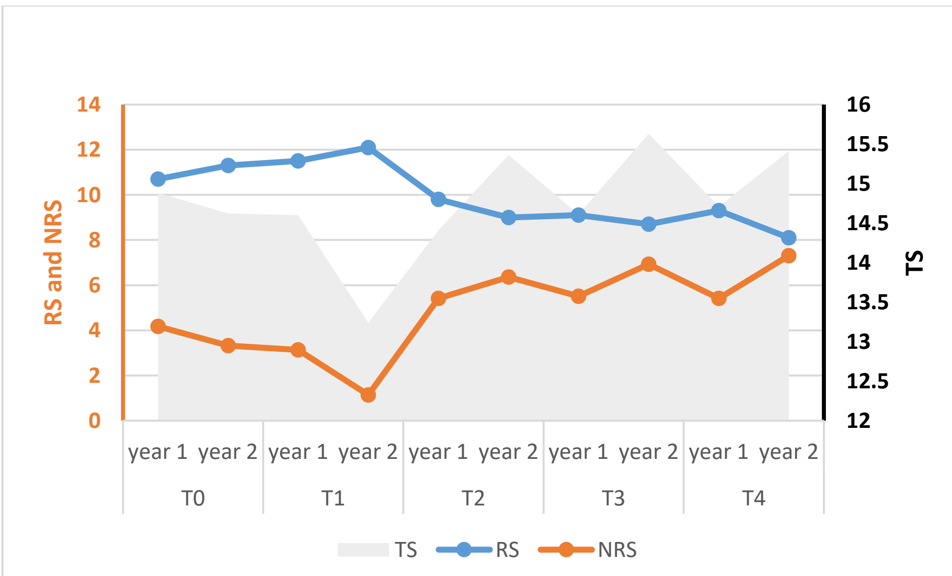

Figure 3: Analysis of Total sugars (TS), reducing sugars (RS), and non-reducing sugars (NRS) in mango fruit under various treatments over two years. All values are expressed as percentages (%).

The analysis of reducing sugars, non-reducing and total sugar content in mango fruit pulp revealed significant variations across all treatments over two years. For reducing sugars, the control treatment (T0) increased from 10.7% in year 1 to 11.3% in year 2, while the chemical treatment (T1) rose from 11.5% to 12.1%. In contrast, natural treatment showed declines: T2 decreased from 9.8% to 9.0%, T3 from 9.1% to 8.7% and T4 from 9.3% to 8.1%. Regarding non reducing sugars, the control treatment decreased from 4.18% to 3.32% and T1 dropped significantly from 3.13% to 1.14%. Conversely natural treatment shows increase T2 rose from 5.41% to 6.36%, T3 from 5.51% to 6.93% and T4 from 5.41% to 7.31%. Total sugars exhibit a similar trend with the control decreasing slightly from one 14.88% to 14.62%. The chemical treatment also declined from 14.60% to 13.24%. However, natural treatment increased: T2 went from 14.41% to 15.63%, and

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T4 from 14.71% to 15.41%. These findings indicate that while chemical treatments tend to enhance reducing sugars initially, they do not sustain total sugar levels over time compared to natural treatments, which consistently improve both non-reducing and total sugars in mango pulp, enhancing its overall sweetness and nutritional profile. The research conducted by Ngereza et al. in 2016 indicated that the levels of both reducing and non-reducing sugar. Unlu et al. (2011) noticed that the growing system can influence the total and reducing sugar levels in tomatoes. Ngereza et al. (2016) observed that reducing sugar levels in conventionally produced pineapple fruits were 20% higher than those in organically produced pineapples compared to their conventional counterparts.

Vitamin C

The vitamin C content in mango varied significantly across all treatments over two years. In year 1, the control treatment (T0) maintained a constituent vitamin C level of 28 mg per 100 grams, while the chemical treatment (T1) started at 27 mg and decreased to 24 mg per 100 grams in year 2, indicating a decline in vitamin C retention. T3 (liquid) treatment increased from 34 mg to 38 mg per 100 grams and T4 treatment went from 35 mg to 40 mg per 100 grams. These results suggest that natural treatment are more effective and enhancing and preserving vitamin C content compared to chemical methods. Overall the findings highlight the superior ability of natural treatments to boost vitamin C levels in mango pulp over the time, while chemical treatments tend to diminish this essential nutrient. This underscores the potential benefit of using natural methods in mango cultivation for improved nutritional quality. Similar results observed by the study conducted by Esch et al. (2010), that certain fruits, specifically kiwi, lemon, mango and apple, contain higher levels of vitamin C when grown without chemicals rather than with chemical fertilizers and pesticides.

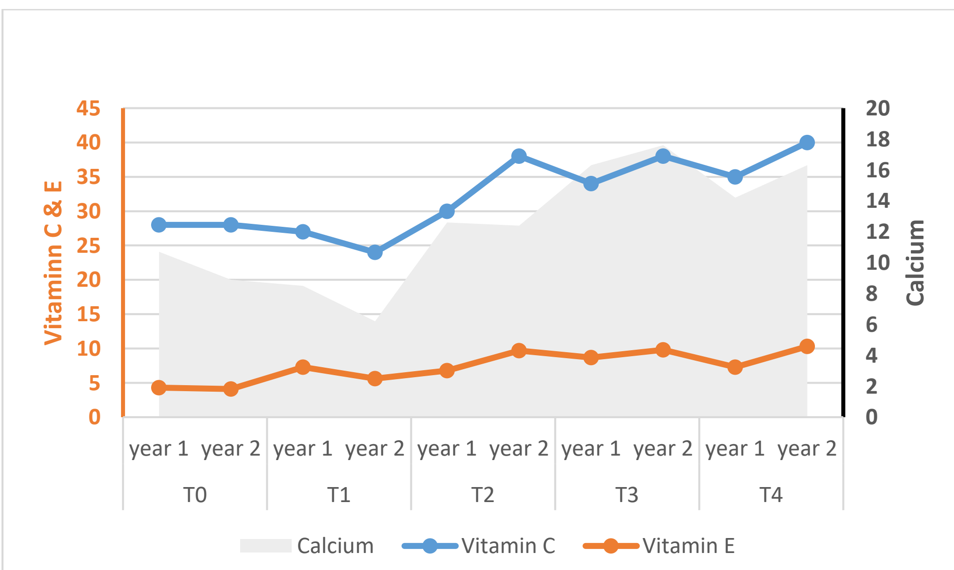

Figure 4: Vitamin C, Vitamin E, and Calcium content of mango fruit under various treatments over two years. Vitamin C and Calcium values are expressed in mg per 100 grams, while Vitamin E is expressed in micrograms per 100 grams.

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Vitamin E

A comparative analysis of conventional (T1) and natural treatments (T2, T3, T4) for mango reveals significant variation in vitamin E content across two years. The conventional treatment (T1) demonstrated a decline in vitamin E levels, decreasing from 7.3 µg/100 grams in year 1 to 5.6 µg/ 100 grams in year 2, indicating a substantial reduction in vitamin E availability. In contrast natural treatment showed more stable vitamin E profiles: the solid treatment (T2) increased from 6.8 µg/100g to 9.7 µg/100g, the liquid treatment (T3) rose from 8.7 µg/100g to 9.8 µg/100g and the combination of treatment (T4) exhibited a significant improvement from 7.3 µg/100g to 10.3 µg/100g. Statistical analysis at the 0.05 significance level suggests that the combination treatment of solid and liquid natural treatments demonstrating the most substantial vitamin E enhancement over the two year period.

Calcium

A study conducted in 2016 by Ngereza et al., concluded that the cultivation methods can influence the calcium content of the mango fruits between organically and conventional cultivated mango fruits. A comparative analysis of conventional (T1) and natural treatments (T2, T3, T4) reveals a significant variation at 0.05 significant level in calcium content across two years. The conventional treatment (T1) demonstrated a consistent decline in calcium levels decreasing from 8.5 mg/100g in year 1 to 6.2 mg/100g in year 2, indicating a gradual reduction in calcium availability. In contrast, natural treatments showed more promising and stable calcium profiles: the solid treatments (T2) remained relatively consistent (12.6 mg/100g to 12.4 mg/100g), the liquid treatment (T3) exhibited a notable increase from 16.3 mg/100g to 17.6 mg/100g, and the combination of treatments (T4) showed a significant improvement from 14.2 mg/100g to 16.3 mg/100g. Overall, the natural treatments particularly liquid treatment (T3) and the combination of treatments (T4) approaches more effective and sustainable calcium management compared to the conventional method over the two year period. Also Ngereza et al., (2016) noticed that the calcium content in pineapple fruits produced without chemicals was 20% higher compared to those grown through conventional methods. This finding aligns with similar results reported by Magkos et al. 2009 and Gastol and Domagala-Swiatkiewicz (2012).

Energy

The study conducted by Austin et al. (2011) concluded that the energy value of a diet is influenced by its carbohydrate, fat, and protein content. Specifically, a higher content of protein, carbohydrates, and fat leads to an increased energy value derived from the diet. A comparative analysis of conventional (T1) and natural treatments (T2, T3, T4) reveals significant variation in energy content across two years. Statistical analysis at the 0.05 significance level demonstrated that the control treatment (T0) and natural treatments particularly T4 (combination of solid and liquid treatment), exhibited superior energy dynamics compared to the conventional treatment (T1). The control group showed an energy increase from 85.04 kcal/100g to 102.32 kcal/100g, while the conventional treatment declined from 59.52 kcal/100g to 50.16 kcal/100g, T3 (liquid) treatment rose from 91.28 kcal/100g to 109.44 kcal/100g, and T4 demonstrated the most remarkable performance escalating from 122.4 kcal/100g to 128.32 kcal per 100 grams. These

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results suggest that natural treatments, especially the combined solid and liquid approach (T4), offer more stable and potentially more efficient energy rich fruits compared to conventional methods.

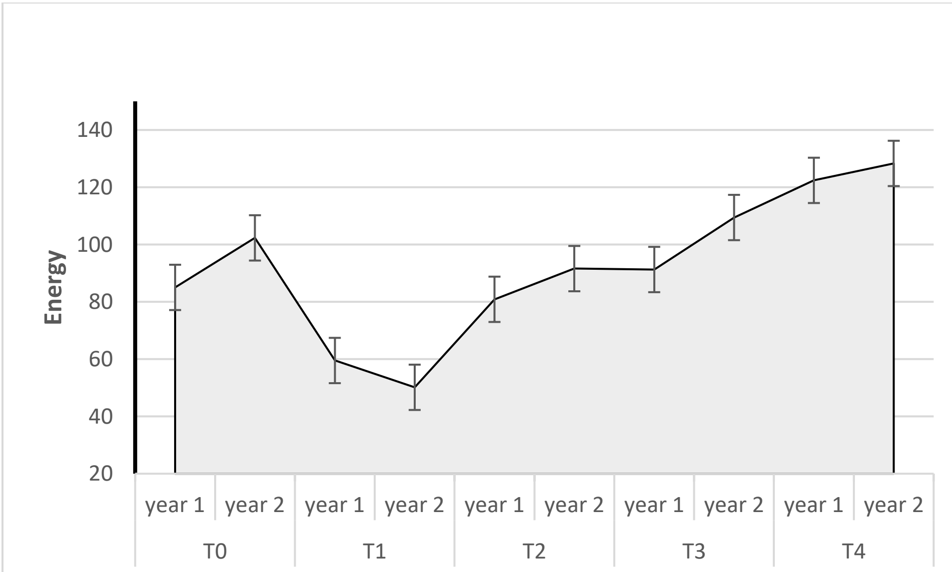

Figure 5: Energy content of mango fruit measured in kilocalories (kcal) per 100 grams under various treatments over two years.

5. CONCLUSION

The comprehensive analysis of various treatments applied to mango fruit over two years reveals that natural methods consistently outperform chemical treatment in enhancing key quality attributes. Natural treatments significantly improve the TSS to titrable acidity ratio, moisture content, protein levels, and vitamin C content, while maintaining or slightly increasing ash levels. Although chemical treatments may initially enhance certain parameters, such as reducing sugars and carbohydrate content but they fail to sustain these benefits overtime. Furthermore, fat and fiber content remain largely unaffected by treatment methods, with control and chemical treatments proving more effective for fiber retention. Overall, these findings underscore the advantages of adopting natural treatments in mango cultivation to improve bio-chemical characteristics of mango fruit. Given the rising global health concerns related to nutrient deficiencies especially in Protein, Vitamin C, and Calcium incorporating nutrient rich crops cultivated with natural bio cultures can provide a viable solution.

6. FUTURE PERSPECTIVES

Future research will explore the seasonal variability in the efficacy of Amritjal and Ghanamrit, examining how different environmental conditions affect their performance and optimal

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application strategies. Additionally, further investigation will focus on understanding how these bio formulations contribute to enhancing the disease resistance of mango tree, aiming to reduce the reliance on synthetic pesticides and promote healthier, more resilient mango orchards. This includes identifying the specific mechanisms through which the bio formulations stimulate the plant's immune system and defensive responses against common mango diseases.

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