Bioactive, Microbiological and Organoleptic Characteristics of Kiwi Lemongrass Blended Nectar

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ABSTRACT

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| The aim of the present study was to develop kiwi lemongrass blended nectar and to assess the bioactive, microbiological and organoleptic parameters during ambient storage conditions. For the development of kiwi lemongrass nectar, kiwi and lemongrass were blended in different proportions of 100:0, 97:03, 94:06, 91:09, 88:12, 85:15 and 82:18, respectively. The nectar was filled into pre-sterilized glass bottles and its storability under ambient conditions was examined after every 30 days. The results revealed that treatment T7 recorded highest antioxidant activity of 49.35 percent and lowest total plate count of 1.07 x 103cfu per ml. Sensory evaluation of nectar revealed that highest mean colour score was recorded in T4 (7.99) whereas, treatment T5, was adjudged as superior in flavour (7.95), taste (8.17), consistency (7.90) On the basis of organoleptic parameters, the blend having 88% kiwi pulp and 12% lemongrass was found best and safe to consume for 90 days of storage. |

*Keywords: kiwi, lemongrass, microbiological, organoleptic and ambient*

1. INTRODUCTION

Consumers are interested in functional foods and beverages that are high in vitamins, dietary fiber and other healthy components as part of their concern for food quality and public health (Gupta *et al*., 2023). One of the key source of numerous significant phytochemicals with a variety of functions in bodily cells, such as detoxification, enzyme induction and antioxidants are fruits (Jideani *et al.,* 2021).Fruits are the major source of carbohydrates, minerals, vitamins, dietary fibers and other bioactive compounds. Fruits are essential part of a balanced diet and are crucial for maintaining public health (Wootton-Beard and Ryan, 2011).

 The kiwi fruit (*Actinidia deliciosa*) is a member of the genus *Actinidia* and family *Actinidiaceae* and are also known as Macaque peach and Chinese gooseberry. It is among the fruits that are extensively commercialized internationally. In addition to having a high vitamin C content, kiwifruits also contain a variety of other nutrients, such as dietary fiber, potassium, vitamin E and folate, as well as a number of bioactive substances, such as a variety of antioxidants, phytonutrients and enzymes that have metabolic and functional benefits (Richardson *et al*., 2018). It is also loaded with phytochemicals and its parts are well recognized for their medicinal and therapeutic properties against diseases associated with the cardiovascular system, diabetes, kidney problems, cancer, digestive disorders, bone and eye problems (Satpal *et al.,* 2021). Kiwifruit supports the immune function of the human and reduces the infestation of diseases such as cold and reduces the length of its symptoms. Kiwifruits are also used for the treatment of stomach cancer, lung cancer, liver cancer, hyperlipidemia and hypertension (Tighe-Neira *et al*., 2017). Kiwifruit postharvest practices influence its nutritional and sensory quality. Morphological appearances and physico-chemical features (soluble solids content, firmness, ascorbic acid content and titratable acidity) are fruit quality indices to determine maturation, harvest time and shelf life (Wang *et al.,* 2021).

 Lemongrass (*Cymbopogon citratus*) is a tall, aromatic grass that is a member of the Graminacae (*Poaceae*) family. *Cymbopogon* is a genus with roughly 55 different species. Their leaves, which emerge from rhizomatous root stock, can reach height of 1.8 metres and a breadth of 1.2 metres. The term “lemongrass” derives from the unique lemony aroma of the essential oil present in the shoot. It is one of the most useful herbs for nutritional as well as functional component of foods. Lemongrass folk medicine associated with health claims such as treatment in coughs, constipation, elephantiasis flu, gingivitis, headache leprosy, malaria, ophthalmia, pneumonia, vascular disorders, diarrhoea and stomach-ache. It has been claimed to be vasorelaxant, diuretic, remedy in treating ringworm infestation, for nervous, gastrointestinal disturbances, fevers and hypertension (Nambiar and Matela, 2012). Each 100g of lemongrass contains 99 calories. The essential oil, minerals, vitamins, and antioxidants it contains give it therapeutic qualities. The aldehydic chemical citral is what gives lemon its unique flavor. Lemongrass's citral components have potent antibacterial and antifungal qualities which exhibits various health benefits, including alleviation of diarrheal conditions, reduction of inflammation, effective suppression of *Plasmodium berghei* growth in comparison to malaria medications, antioxidant and free radical scavenging properties, reduction of elevated cholesterol levels (depending on dosage), and neurobehavioral effects (Kumar *et al*., 2010). The present investigation of kiwi lemongrass blended nectar was undertaken to assess the quality during 3 months of storage under ambient conditions.

2. material and methods

For the experiment kiwi fruit and lemongrass were collected from local market of Jammu region and IIIM Farm, Chatha Jammu, respectively. Fresh raw materials were washed under running tap water to eliminate dirt and other irrelevant material. The kiwi fruit were then peeled, cut and pulp was extracted using hot break pulping method (Lal *et al*, 2002). The extracted pulp was used for further processing. Then kiwi juice was extracted with a ratio of lemongrass to water 1:4 (w/v) and boiled in reflecting condenser for 30 min., then the mixture was filtered using muslin cloth (Assous *et al.,* 2013). Kiwi fruit pulp and lemongrass extract were blended in distinct proportions as T1 (100:00:: Kiwi pulp: Lemongrass extract), T2 (97:03:: Kiwi pulp: Lemongrass extract),Tз (94:06:: Kiwi pulp: Lemongrass extract ), T4 (91:09:: Kiwi pulp: Lemongrass extract), T5 (88:12:: Kiwi pulp: Lemongrass extract), T6 (85:15:: Kiwi pulp: Lemongrass extract) and T7(82:18:: Kiwi pulp: Lemongrass extract). TSS and acidity of the nectar was maintained at 15 Brix and 0.3 % with the help of sugar and citric acid wherever necessary, then heated at 85°C for 10 minutes. Immediately after pasteurization, the nectar was filled into pre-sterilized glass bottles of 250 ml capacity keeping 1.5-2 cm head space. The filled bottles were sealed airtight using crown caps with the help of crown corking machine. Then the bottles were pasteurized at 85°C for 15 minutes, cooled to room temperature and labeled.

Free radical scavenging activity was estimated using 1,1-diphenyl-2-picryl-hydrazyl (DPPH). Five hundred micro litres of 0.5 Mm DPPH solution and 2 ml of 80 per cent methanol aqueous solution were mixed with 25 µl of methanolic extract of sample and absorbance was determined at 517 nm using blank as 80 per cent methanol and tris buffer after maintaining at 20℃. Total phenolic content of sample was estimated by Folin-Ciocalteau (FC) method which is an electron transfer based assay (Ahmed and Abozed, 2015). About 50 µl of the sample extract was mixed with 250 µl of freshly prepared Folin-Ciocalteau reagent. The microbial count (total plate count and yeast and mold count) was estimated by using standard method of FSSAI (2011). Sensory evaluation of kiwi-lemongrass blended nectar was done by the panel of 10 semi-trained judges using 9 point hedonic rating scale (scores assigned as 9 "like extremely" to 1 "dislike extremely") as described by Amerine *et al*. (1965). The cost of production of kiwi-lemongrass blended nectar was determined by taking into consideration the cost of raw materials, chemicals and packaging materials, etc. used in manufacturing of the product.

The data obtained was statistically analyzed using Factorial completely randomized design (CRD) for interpretation of results through analysis of variance at significant level (p≤ 0.05).

3. results and discussion

**3.1 Effect of blending on Antioxidant activity (%)**

Fig. 1 The mean antioxidant activity among control and final treatment with 18 percent lemongrass extract showed a increase of 43.91 per cent. The antioxidant activity (Fig 1) showed a decrease of 1.15 per cent during the storage period of 90 days. Antioxidant activity of herbal nectar increased with the incorporation of lemongrass extract which might be due to higher antioxidant activity in lemongrass. The results were in line with the findings of Hirdyani (2015) who evaluated quality of RTS beverages made from medicinal plants and Birwal *et al.* (2025) who developed lemongrass-based kefir beverage.

**3.2 Effect of blending on total phenolic content (mg GAE/100ml)**

Among control and treatments, 20.27 per cent increase was recorded in total phenols, with increase in lemongrass nectar (Table 1). The incorporation of lemongrass in the blended nectar decreased the total phenolic content of the product which might be due to lower total phenol content in lemongrass. Similar observations have been reported by Hamid *et al.* (2017) in spiced squash prepared from mulberry. Decrease in total phenol content with the progression of storage period from 764.73 to 764.38mg GAE per 100 ml was observed which might be attributed to the volatile nature of phenolic compounds which easily get oxidized (Bhargawa *et al*., 2014). Similar results have been observed in guava and mango drink by Yadav and Singh (2014) and cape gooseberry RTS by Hemalatha *et al*. (2018).

**3.3 Effect of blending on Microbial count (Total plate count and Yeast and Mold)**

 There was no microbial growth in kiwi-lemongrass blended nectar upto 60 days of storage at ambient conditions. However, after 90 days of storage (Table 2), highest total plate count of 1.41 x 103cfu per ml was observed in treatment T1(100:00:: Kiwi pulp: Lemongrass extract) whereas, the lowest count of 1.07 x 103cfu per ml was recorded in T7 (82:18:: Kiwi pulp: Lemongrass extract). Yeast and mold count also remained undetected upto 60 days of storage but after 90 days of storage (Table 2), highest yeast and mold count of 0.24 x 103cfu per ml was recorded in treatment T1 (100:00:: Kiwi pulp: Lemongrass extract) whereas, the lowest yeast and mold count of 0.07 × 103cfu per ml was recorded in T7 (82:18:: Kiwi pulp: Lemongrass extract). With incorporation of lemongrass juice total plate count and yeast and mold count decreased which might be due to the antimicrobial properties possessed by lemongrass (Bozin *et al*., 2006). The total plate count remained within the safe limits (104cfu/ml) specified by FSSAI (2018). Similar trend of microbial growth have been reported by Kumar and Bangaraiah (2014) in whey-sweet orange based RTS beverage.

**3.4 Organoleptic evaluation of kiwi- lemongrass nectar**

The highest mean colour score was recorded in T4 as 7.99 and the lowest mean score of 7.20 was recorded in T5 Declining trend was observed in colour score when blended with lemongrass extract which could be attributed to green colour contributed by lemongrass leaves. The lowest mean score of 7.20 was recorded in T5 (88:12:: Kiwi pulp: Lemongrass extract (Fig 2). Kumari *et al*. (2011) in tulsi flavoured yoghurt and Majumder *et al*. (2018) in bottle gourd blended herbal drink recorded similar results. The colour scores decreased with the progression of storage period from 7.84 to 7.30 which might be due to degradation of colour pigment and browning caused by copolymerization of organic acids of the product (Hamid *et al.,* 2017).

The mean flavour score was recorded maximum (7.95) in T5 (88:12::Kiwi pulp: Lemongrass extract) and the minimum mean value of 6.95 was recorded in T7 (82:18:: Kiwi pulp: Lemongrass extract (Table 3). The mean score for flavour declined from 7.84 to 7.12 in kiwi-lemongrass blended nectar, which might be due to certain enzymatic, physiological or biological changes during 90 days of storage. The decline in flavour scores with advancement of storage period might also be due to the decline in volatile aromatic compounds (Yadav *et al*., 2010). During storage there is high level of acid that reacts with the product causing unpleasant volatile odour or slight fermentation of beverage and gas production (Rashid *et al*., 2018).

Among treatments, T5 (88:12:: Kiwi pulp: Lemongrass extract)showed maximum mean taste score of 8.17 and the minimum mean value of 7.42 was recorded in T7 (82:18:: Kiwi pulp: Lemongrass extract) (Table 3). Addition of lemongrass extract enhanced the taste score significantly upto 12 per cent but its higher concentration degraded the taste because of the pungency in lemongrass. Significant decrease in taste score was observed which varied from 8.03 to 7.49 during storage period of 90 days. The decline in taste scores could also be due to development of acidity and caramelization (Rashid *et al*., 2018).

Table 4 showed The mean consistency score which was recorded highest as 7.90 in treatment T5 (88:12::Kiwi pulp: Lemongrass extract) whereas, treatment T7 (82:18:: Kiwi pulp: Lemongrass extract) recorded the lowest mean consistency score of 7.02. An increase in consistency score was observed when lemongrass extract was added but their higher concentration decreased the consistency of nectar. Similar results have been observed in kiwi fruit RTS beverage by Bochare *et al*. (2020). The consistency scores decreased significantly from 7.76 to 7.08, during 90 days of storage in kiwi-lemongrass blended nectar. The decline in consistency scores might be due to the interaction between phenols and protein as well as the formation of cation complexes with pectin and phenols (Hamid *et al.*, 2017).

**3.5 Economics of kiwi lemongrass nectar**

The cost of production of kiwi-lemongrass blended nectar T5(88:12::Kiwi pulp : Lemongrass extract) is based upon cost of all the ingredients used and some other factors (Table 5). The cost was calculated on the basis of current market prices of all the ingredients in the market. The cost of production per 250 ml bottle came out to be ₹27.54. Since the cost of production has been calculated on laboratory scale basis, some reduction in the cost of production on large scale can be expected.

**Table 1.Effect of treatment and storage on total phenols (mg GAE/100 ml) of kiwi lemongrass blended nectar**

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Storage period (days)** | **Mean**(Treatment) |
| **0** | **30** | **60** | **90** |
| **T1 (100:00:: Kiwi pulp: Lemongrass extract)** | 900.16 | 899.80 | 899.45 | 899.05 | **899.61** |
| **T2 (97:03:: Kiwi pulp: Lemongrass extract)** | 879.30 | 878.88 | 878.45 | 878.02 | **878.66** |
| **T3 (94:06:: Kiwi pulp: Lemongrass extract)** | 854.64 | 854.24 | 853.81 | 853.42 | **854.02** |
| **T4 (91:09:: Kiwi pulp: Lemongrass extract)** | 832.52 | 832.11 | 831.70 | 831.20 | **831.88** |
| **T5 (88:12:: Kiwi pulp: Lemongrass extract)** | 810.97 | 810.47 | 810.08 | 809.55 | **810.26** |
| **T6 (85:15:: Kiwi pulp: Lemongrass extract)** | 789.05 | 788.67 | 788.25 | 787.80 | **788.44** |
| **T7 (82:18:: Kiwi pulp: Lemongrass extract)** | 765.41 | 765.01 | 764.47 | 764.04 | **746.73** |
| **Mean (Storage)** | **764.73** | **764.56** | **764.41** | **764.38** |  |
| **Effects C.D (p≤0.05)**Treatment 0.05Storage 0.04Treatment × Storage 0.10 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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| --- | --- | --- |
| **Treatments** | **Total plate count** **Storage periods (days)** |  **Yeast and mold count** **Storage periods (days)** |
| **0** | **30** | **60** | **90** | **0** | **30** | **60** | **90** |
| **T1(100: 00::KP:LG)** | **ND** | **ND** | **ND** | **1.41** | **ND** | **ND** | **ND** | **0.24** |
| **T2(97:03:: KP:LG )** | **ND** | **ND** | **ND** | **1.37** | **ND** | **ND** | **ND** | **0.21** |
| **T3(94: 06::) KP:LG)** | **ND** | **ND** | **ND** | **1.34** | **ND** | **ND** | **ND** | **0.18** |
| **T4 (91: 09:: KP:LG)** | **ND** | **ND** | **ND** | **1.20** | **ND** | **ND** | **ND** | **0.14** |
| **T5 (88:12:: KP:LG)** | **ND** | **ND** | **ND** | **1.15** | **ND** | **ND** | **ND** | **0.11** |
| **T6(85:15:: KP:LG)** | **ND** | **ND** | **ND** | **1.10** | **ND** | **ND** | **ND** | **0.09** |
| **T7 (82:18:: KP:LG)** | **ND** | **ND** | **ND** | **1.07** | **ND** | **ND** | **ND** | **0.07** |
| **Mean (Storage)** | **ND** | **ND** | **ND** | **1.23** | **ND** | **ND** | **ND** | **0.14** |
| **Effects C.D (p≤0.05)****Treatments 0.02****ND= Not detected** **KP: Kiwi pulp****LG: Lemongrass extract** | **Effects C.D (p≤0.05)****Treatments 0.01****ND= Not detected** **KP: Kiwi pulp****LG: Lemongrass extract** |

**Table 2: Effect of treatment and storage on total plate count (× 103cfu/ml) yeast and mold count (× 103cfu/ml) of kiwi-lemongrass blended nectar** |  |

**Table 3: Effect on treatment and storage on flavour (hedonic scale) and taste (hedonic scale) of kiwi-lemongrass blended nectar**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Flavour****Storage periods (days)** | **Mean** **(Treatments)** |  **Taste****Storage periods (days)** | **Mean** **(Treatments)** |
| **0** | **30** | **60** | **90** | **0** | **30** | **60** | **90** |
| **T1(100: 00::KP:LG)** | **7.76** | **7.57** | **7.34** | **7.00** | **7.41** | **7.84** | **7.78** | **7.45** | **7.32** | **7.59** |
| **T2(97:03:: KP:LG)** | **7.86** | **7.70** | **7.48** | **7.17** | **7.55** | **8.01** | **7.87** | **7.64** | **7.51** | **7.75** |
| **T3(94: 06::) KP:LG)** | **7.98** | **7.82** | **7.63** | **7.30** | **7.68** | **8.15** | **8.00** | **7.83** | **7.61** | **7.89** |
| **T4 (91: 09:: KP:LG)** | **8.07** | **7.93** | **7.72** | **7.44** | **7.78** | **8.24** | **8.13** | **7.95** | **7.72** | **8.01** |
| **T5 (88:12:: KP:LG)** | **8.22** | **8.08** | **7.86** | **7.59** | **7.95** | **8.38** | **8.28** | **8.13** | **7.91** | **8.17** |
| **T6(85:15:: KP:LG)** | **7.61** | **7.45** | **7.20** | **6.88** | **7.28** | **7.72** | **7.66** | **7.39** | **7.26** |  **7.50** |
| **T7 (82:18:: KP:LG)** | **7.42** | **7.10** | **6.81** | **6.48** | **6.95** | **7.65** | **7.70** | **7.23** | **7.11** | **7.42** |
| **Mean (Storage)** | **7.84** | **7.66** | **7.43** | **7.12** |  | **8.03** | **7.91** | **7.66** | **7.49** |  |
| **Effects C.D (p≤0.05)****Treatment 0.05****Storage 0.04****Treatment × Storage 0.11****KP: Kiwi pulp****LG: Lemongrass extract** | **Effects C.D (p≤0.05)****Treatments 0.04** **Storage 0.03****Treatments × Storage 0.08****KP: Kiwi pulp****LG: Lemongrass extract** |

**Table 4: Effect of treatment and storage on consistency (hedonic scale) of kiwi-lemongrass blended nectar**

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Storage period (days)** | **Mean**(Treatment) |
| **0** | **30** | **60** | **90** |
| **T1 (100:00:: Kiwi pulp: Lemongrass extract)** | 7.61 | 7.36 | 7.19 | 6.96 | **7.28** |
| **T2 (97:03:: Kiwi pulp: Lemongrass extract)** | 7.73 | 7.48 | 7.30 | 7.09 | **7.39** |
| **T3 (94:06:: Kiwi pulp: Lemongrass extract)** | 7.84 | 7.57 | 7.39 | 7.12 | **7.48** |
| **T4 (91:09:: Kiwi pulp: Lemongrass extract)** | 8.11 | 7.89 | 7.66 | 7.42 | **7.77** |
| **T5 (88:12:: Kiwi pulp: Lemongrass extract)** | 8.23 | 8.02 | 7.81 | 7.54 | **7.90** |
| **T6 (85:15:: Kiwi pulp: Lemongrass extract)** | 7.50 | 7.27 | 7.12 | 6.82 | **7.18** |
| **T7 (82:18:: Kiwi pulp: Lemongrass extract)** | 7.36 | 7.15 | 6.91 | 6.67 | **7.02** |
| **Mean (Storage)** | **7.76** | **7.53** | **7.34** | **7.08** |  |
| **Effects C.D (p≤0.05)**Treatment 0.04Storage 0.03Treatment × Storage 0.08 |

**Table 5: Cost of production of kiwi-lemongrass blended nectar**

|  |  |  |
| --- | --- | --- |
| **Ingredients** | **Rate @** ₹ | **Kiwi lemongrass blended nectar****T5(88:12:: Kiwi pulp : Lemongrass extract)** |
| **Quantity (g)**  | **Amount (** ₹**)** |
| Kiwi | 200/kg | 200g | 40 |
| Lemon grass  | 100/kg | 80g | 8 |
| Sugar | 50/kg | 120 g | 6.00 |
| Glass bottles (250 ml) | 3/bottle | 4 | 12 |
| Labels | 0.15/ label | 4 | 0.2 |
| Crown corks | 0.25/cork | 4 | 2.4 |
| Total cost of ingredients |  | **68.60** |
| Overhead charges (fuel and electricity) | @ 15% | 10.29 |
| **Total input cost** |  | **78.89** |
| Machinery depreciation @ 10% on the total machinery cost of 20,000 for 300 working days in a year | @ 10% | 2000 |
| Machinery depreciation for one day |  | 6.66 |
| Profit @15 of total variable cost and fixed cost | @ 15% | 12.83 |
| GST @ 12 of total variable cost, fixed cost and profit | @ 12% | 11.80 |
| **Grand total for 1litre product (₹)** |  | **110.18** |
| **Cost per bottle of 250 ml (₹)** |  | **27.54** |

**Fig.1: Effect of treatment and storage on antioxidant activity (%) of kiwi-lemongrass blended nectar**

**Fig.2: Effect of treatment and storage on colour of kiwi-lemongrass blended nectar**

4. Conclusion

[The study highlighted that for developing a good quality nectar, kiwi-lemongrass could be blended in the ratio's of 88:12, respectively. The formulated kiwi-lemongrass blended nectar retained its quality throughout storage period of 90 days with total microbial load within safe limits. Thus, formulated beverage could be a good substitute to chemical or synthetic beverages which have no nutritional value. Including and maximizing the use of medicinal plants in beverages might help reap all the health advantages and reduce chance of contracting major disease to people and formulation of such type of beverages can also be economically beneficial to the growers.

**DISCLAIMER (ARTIFICAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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