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Potential Therapeutic Effects of Garlic Peel and Kiwi Fruit as a Healthy Dietary Supplement in Bread for Elderly People

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Abstract

In elderly populations, nutrient deficiencies contribute to disorders including cardiovascular disease, kidney problems, cancer, digestive disorders, and bone and eye conditions. Garlic (Allium sativum) is widely used in food for its therapeutic properties, while kiwi fruit (Actinidia deliciosa) is rich in vitamins, minerals, and phytochemicals with therapeutic activity. This study evaluated kiwi fruit and garlic peel powder for developing a nutrient-rich dietary supplement bread through sensory, proximate, and mineral analyses. Bread was formulated with all-purpose flour, 5% oat bran, and increasing levels of kiwi fruit and garlic peel (3:1%, 6:2%, 9:3%, and 12:4%). Among the treatments, T3 (9% kiwi fruit, 3% garlic peel) was identified as the optimum formulation. Compared with the control, T3 showed reduced springiness (0.457% vs. 0.623%) and higher calcium content (82.925 vs. 13.44 mg/100 g). Proximate analysis revealed 13.14% protein in T3 compared with 8.62% in the control, along with increased carbohydrate content relative to the control. Colour analysis showed measurable shifts in L, a*, and b* values with increasing fortification. Higher levels of kiwi fruit and garlic peel affected bread texture and appearance in sensory evaluation. Overall, T3 (9% kiwi fruit, 3% garlic peel) produced bread with the best balance of texture, aroma, and nutrient enrichment, supporting its potential as a therapeutic, nutrient-dense dietary option for elderly populations.*

Keywords: *Bread, Garlic, Kiwi, Kidney, Nutritive, Texture.*

Abbreviations: *CVD – cardiovascular disease; PET – Polyethylene Terephthalate; AAS – Atomic Absorption Spectrophotometer*

Introduction

The elderly population is rapidly increasing, and predictions show that by 2050 this group will constitute 30% of the global population. The ageing process produces a series of reversible changes, mainly related to body composition, physical activity as well as dietary intake [1]. India is an emerging nation where the population relies on staple foods like wheat, rice and maize to provide calories and proteins. While refined flour (all-purpose flour) is widely utilised in the creation of baked goods like bread and pastries, whole wheat meal (atta) has traditionally only been made from wheat to make chapattis, paratha and pooris. Among these, bread is a common dish made from flour (dough) and water, usually baked, and is also one of the first and oldest artificial foods enjoyed by people all over the world [2]. Oat bran is highly nutritious and offers several health benefits due to its rich content of fibre, vitamins, minerals and antioxidants. Oats are a good element for supplements because of their high nutritional content, low cost, usefulness as a source of protein and appealing bland flavour [3].

Garlic (Allium sativum) is a common culinary component because of its medicinal qualities. Despite making up to 25% of the total production, the industry regrettably discards garlic peel. A good source of phytochemicals and therapeutic compounds is garlic peel. Many civilisations have acknowledged the possible use of garlic peel to prevent and treat sickness throughout history [4]. Garlic has also been reported to lower the incidence of gastrointestinal illness caused by cryptosporidiosis in immunocompromised mice and to reduce inflammation [5]. The potential nutrients promote cardiovascular health, immune function and overall health [6]. Kiwi fruit, also known as Actinidia deliciosa, is a subtropical fruit in the Actinidiaceae family. The fruit, which has a distinct flavour, is currently grown commercially in a number of countries, primarily in Brazil, Italy and New Zealand. It has a high content of fibre, minerals and phytochemicals known as bioactive substances with antioxidant capacity, which either scavenge free radicals or stop them from forming [7]. Vitamin C (ascorbic acid) is a vital dietary nutrient found in kiwi fruit for people, since humans lack the terminal enzyme L-gulono-γ-lactone oxidase in the ascorbate biosynthetic pathway [8].

The nutritional importance includes a low contribution of energy, carbohydrate, protein and lipids and a high contribution of water, minerals and vitamins [9]. Furthermore, incorporation of these functional foods in the diet, in combination with healthy traditions and lifestyles, can help promote digestion, the immune system and cardiovascular health in the elderly [10].
To the best of our knowledge, the combination of kiwi and garlic peel in bread production for increasing the functionality and their effects on physicochemical characteristics that can act as a therapeutic agent in elderly people is less considered. Thus, the goal of the present study was to optimise various concentrations of kiwi fruit and garlic peel powder for the development of a nutrient-rich dietary supplement bread by evaluating its sensory characteristics, proximate analysis and mineral compositions, which enable health benefits in the elderly population.

Materials and Methods

Preparation of oat bran flour

Oat bran was purchased from Agile Organic on Amazon and ground to a fine powder, sieved to remove dirt and foreign matter, and stored at ambient temperature in a closed bottle for further use [11].

Preparation of kiwi fruit pulp

Fresh kiwi fruits were purchased from a local market in Coimbatore, washed, peeled, and the pulp was ground and stored in a refrigerator using PET jars until use for incorporation in bread [12].

Preparation of garlic peel powder

Garlic bulbs were purchased from a local market, and the peels were manually collected in a separate bowl. The collected peels were dehydrated in a hot air oven at 55°C for 2–3 days until the peels turned a light brownish colour and developed aroma. The peels were then powdered, sieved and stored in a closed container at ambient temperature [13].

Dough preparation

The production of dough was performed according to the method described in [14], with slight modifications. All the constituents (Table 1) were stirred properly, and yeast and water were added to form a viscoelastic dough. Kneading of the dough was carried out for 30 min to ensure uniform distribution of the yeast. The dough was mildly shaped into a round ball and placed in a vessel for 40–80 min until it doubled in size. A damp towel was placed on the mould to prevent any skin formation on the dough. Finally, the dough was baked at 180°C for 30 min [14].

Table 1: Major constituents in the dough

Constituents	Control (g)	T1 (g)	T2 (g)	T3 (g)	T4 (g)
Oat bran	0	50	50	50	50
Kiwi pulp	0	30	60	90	120
Garlic peel	0	10	20	30	40
All-purpose flour	1000	910	870	830	790

Note: The recipe used in the control was the basic formula.

Proximate analysis composition

The proximate analysis of the bread sample was performed according to the standard method described in [15]. The crude protein, crude fat, crude fibre, ash and moisture content were determined for the samples prepared. The analysis was done in triplicate, and the results were estimated and expressed as grams per 100 g of dry matter basis [15].

Mineral composition analysis

The bread samples were analysed for minerals such as iron (Fe), calcium (Ca), magnesium (Mg) and zinc (Zn) using an Atomic Absorption Spectrophotometer, AAS (Model 372, Perkin-Elmer, Beaconsfield, UK), according to the standard method described in [15], with slight modifications as described.

Specific volume of bread

The method described in [16] was applied to measure the specific volume of bread after baking, by the rapeseed displacement method. The specific volume of bread was calculated by dividing the loaf volume by the loaf weight, in mL/g [16].

Texture profile analysis determination

The texture analysis was conducted according to the method described in [17], with slight modifications. A texture analyser (TA HD Plus, Stable Micro Systems) was used to measure the hardness, springiness, cohesiveness and chewiness of the bread sample [18]. For firmness, the sample was removed from its storage place and placed at the centre over a support just prior to testing. The texture profile analysis was performed at a pre-test speed of 1.0 mm/s and a test speed of 1.7 mm/s, using a 5 kg load cell.

Colour analysis profile

The colour analysis was measured with a slight modification of the method described in [19], using a Hunter Lab colorimeter (model SM-3001476, micro sensors, New York). The colour was calibrated using a user-supplied black plate calibration standard for the zero setting and white calibration plates for the white calibration settings. Three distinct exposures were made to the instrument at various locations during the experiment. The CIELAB colour measurement system was used to present the readings as L*, a* and b* colour parameters. The value of a*, which represents redness, varied from -100 (redness) to +100 (greenness); b* represents -100 (blueness) to +100 (yellowness); and L*, which represents lightness, ranged from 0 (black) to 100 (white).

Sensory evaluation of bread

Sensory properties of the bread were evaluated by a panel consisting of five semi-trained individuals. A 9-point hedonic rating scale was used to evaluate the crust's colour, appearance, flavour, texture, taste and overall acceptability: 9 for extremely liking, 8 for liking very much, 7 for moderately liking, 6 for liking slightly, 5 for neither liking nor disliking, 4 for slightly disliking, 3 for moderately disliking, 2 for very much disliking, and 1 for extremely disliking [20].

Statistical analysis

Mineral analysis, texture and sensory experiments were performed in triplicate.

All data were calculated and are displayed as mean ± standard deviation. Data were analysed by one-way Analysis of Variance (ANOVA) using SPSS software 27.0 (SPSS Inc., Chicago, USA) for Windows 11. The means were compared using Duncan's Multiple Range Test (DMRT) at a significance level of $p \leq 0.05$.

Results

Formulation of bread

Different combinations of ingredients were used for the preparation of nutritive bread using oat bran, garlic peel and kiwi fruit. The treatments consisted of: control (100% all-purpose flour alone), T1 (91% all-purpose flour, 5% oat bran, 3% kiwi fruit and 1% garlic peel), T2 (87% all-purpose flour, 5% oat bran, 6% kiwi fruit and 2% garlic peel), T3 (83% all-purpose flour, 5% oat bran, 9% kiwi fruit and 3% garlic peel) and T4 (79% all-purpose flour, 5% oat bran, 12% kiwi fruit and 4% garlic peel). Formulations involving T4 were not considered for further analyses, as the dough did not develop the desired elasticity and failed to proof properly. Figure 1 shows the appearance of the various bread treatments after baking.

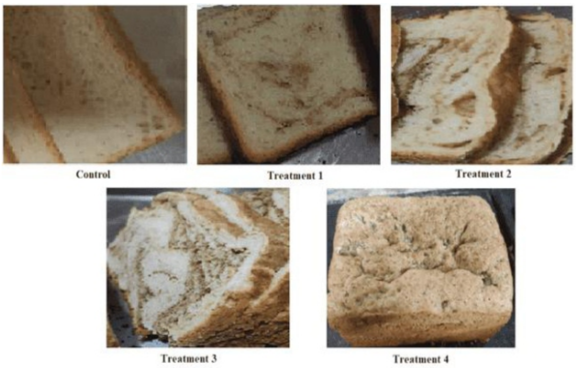

Figure 1: Preparation of bread slices

Proximate composition of bread

Results of proximate analysis of different treatments of bread samples are compared to the control, as shown in Table 2. The moisture content in the T3 sample was significantly higher as the percentage of garlic peel and kiwi fruit in the bread samples increased. This could be due to the high fibre content in both garlic peel powder and kiwi fruit juice.

Table 2: Proximate analysis of various types of bread

Bread Sample	Moisture (%)	Ash (%)	Protein (%)	Fibre (%)	Fat (%)	Carbohydrate (%)
Control	21.6±0.36	1.18±0.0004	8.62±0.0004	6.62±0.0004	0.75±0.0006	66.29±1.15
T1	26.38±1.74	2.37±0.0134	10.1±0.0372	6.94±0.0057	3.36±0.0139	57.03±0.58
T3	30.89±0.11	3.86±0.0286	13.14±0.073	7.04±0.0181	5.18±0.0121	45.92±0.1794

All values are represented as mean ± standard deviation.

Mineral composition analysis

The results of the mineral analysis for each bread sample are summarized in Table 3. The T3 sample showed increased calcium and iron content compared to the other treatments, due to the addition of garlic peel and kiwi fruit.

Table 3: Mineral composition of bread samples

Bread Sample	Calcium	Magnesium	Iron	Zinc
Control	13.44±0.312	45.12±1.185	4.78±0.026	6.98±0.039
T1	81.13±0.336	25.88±0.101	2.83±0.145	1.405±0.076
T3	82.925±0.068	28.9±0.0338	2.87±0.002	1.54±0.007

All values are represented as mean ± standard deviation (mg/100 g).

Specific volume

The specific volume of bread is presented in Table 4. It shows that T3 had a lower volume (4.43 cm^3/g) compared to the control (5.08 cm^3/g) and T1 (4.79 cm^3/g), which were comparatively higher.

Table 4: Effects of different treatments on specific volume

Bread Sample	Specific volume (cm^3/g)
Control	5.08±0.06
T1	4.79±0.04
T3	4.43±0.03

Texture properties of bread

According to Table 5, the addition of oat bran, garlic peel and kiwi fruit significantly affected the textural properties of the bread.

Table 5: Effects of different treatments on texture properties of bread

Bread Sample	Hardness (N)	Springiness (%)	Chewiness (N)	Gumminess (N)	Cohesiveness (%)
Control	3163.2	0.623	1064.163	1708.128	0.54
T1	8291.8	0.529	1710.68	3233.802	0.39
T3	9336	0.457	1471.96	3220.92	0.346

All values are represented as mean ± standard deviation.

Colour analysis of bread

The bread colour varied significantly among the various treatments (Table 6). With regard to colour analysis, incorporation of oat bran, garlic peel and kiwi fruit produced a marked change in colour, to different degrees, compared with the control sample.

The results indicated that incorporation led to a darkening effect, turning the centre of the bread more brownish compared to the control at increased levels.

Table 6: Effects of colour analysis of bread

Combination	L*	a*	b*
Control	79.49	0.82	18.07
T1	73.38	2.73	21.23
T3	66.84	2.72	19.49

Note: The L value represents the lightness of the bread sample. The larger the L* value, the whiter the sample. The a* value represents the green–red degree of the bread sample. The b* value represents the blue–yellow degree of the bread sample.*

Sensory characteristics of bread

Sensory analysis showed that the breads were slightly acceptable at T3 (83% all-purpose flour, 5% oat bran, 9% kiwi fruit and 3% garlic peel). Panellists awarded low scores to the bread prepared as T4 (79% all-purpose flour, 5% oat bran, 12% kiwi fruit and 4% garlic peel), due to the increasing levels of garlic peel and kiwi fruit that led to poor quality. This treatment resulted in the lowest scores for aroma, texture and overall acceptability, due to the undesirable acidic taste imparted by the garlic peel and kiwi fruit (Table 7).

Table 7: Effect of fortification with garlic peel and kiwi fruit on sensory scores (out of 9) of breads

Treatments	Colour	Appearance	Aroma	Texture	Crumb elasticity	Overall acceptability
Control	7.2±0.83	7.2±0.83	7.8±0.83	8.6±0.54	7.6±0.54	8.6±0.54
T1	6.8±0.83	7.2±0.83	7.0±1.00	7.6±0.89	6.8±0.83	8.0±0.71
T2	7.2±0.44	6.8±0.83	7.6±0.54	7.0±1.00	6.8±0.83	8.0±0.00
T3	7.2±0.83	6.8±0.83	7.0±0.70	5.8±0.83	5.4±0.54	7.4±0.54
T4	4.8±0.83	4.4±1.14	5.0±0.70	3.8±0.83	3.8±0.83	5.6±0.54

All values given are means of three determinations.

Discussion

The formulated bread with different ratios revealed that T3 exhibited better texture and aroma at the optimum concentration of 83% all-purpose flour, 5% oat bran, 9% kiwi fruit and 3% garlic peel. Similarly, it has been reported that four composite flours containing different proportions of wheat, chickpea, buckwheat, sorghum, sprouted barley and sprouted wheat were tested, of which the formulations with 50% refined wheat, 10% chickpea, 10% buckwheat, 10% sorghum, 10% sprouted barley and 10% sprouted wheat (MI), and with 50% whole wheat, 10% chickpea, 10% buckwheat, 10% sorghum, 10% sprouted barley and 10% sprouted wheat (MII), were not considered further due to the undesirable elasticity of the dough [21]. According to previous research [22], incorporating garlic powder at various concentrations led to non-significant changes in baking absorption compared to the control group, although the values were consistently higher.

Proximate analysis showed T3 with higher moisture (30.89%) content compared to the other treatments, due to the addition of kiwi fruit pulp. Fruits are reported to naturally contain high levels of moisture content, along with small amounts of vascular tissue [23]. In addition, crude fat, crude protein and crude fibre also showed a gradual, significant rise in the T3 bread sample. Carbohydrate content was relatively lower compared with the control and T1 samples. Similarly, high levels of moisture, fat and fibre content have been reported to increase significantly with the incorporation of jackfruit rind powder in bread samples [24]. Moreover, moisture content was high due to the increased ratio of garlic peel and kiwi fruit pulp, and the T4 sample could not be sliced or used for further studies.

Mineral analysis revealed that the calcium content in the bread samples (81.28–83.45 mg/100 g) increased significantly with the addition of garlic peel and kiwi fruit compared to the control. Similarly, the calcium content of bread samples has been reported to range from 248.5 to 330.5 mg/100 g, increasing significantly with the addition of vegetables [25]. The zinc content in this study for T3 (1.54 mg/100 g) was comparatively higher than for T1 (1.40 mg/100 g). By comparison, the zinc content of moringa-fortified bread has been reported to range from 0.22 to 0.41 mg/100 g [26].

The specific volume results revealed that incorporation of oat bran, garlic peel and kiwi fruit reduced the specific volume of bread in the T3 sample (4.43 cc/g) compared to the control.

Similarly, the specific volume of bread has been reported to decrease to 3.99 cc/g at a 0.5% level of garlic powder incorporation compared to control, due to a reduction in the consistency and strength of the dough caused by thiol compounds [22]. It has also been reported that a higher amount of bran results in a lower specific volume of bread [27]. Bran is reported to contain more insoluble dietary fibre particles that disrupt the structure of the gluten protein, hindering the formation of the gluten network in the dough, which in turn reduces the expansion volume of the dough and the resulting bread [28]. With regard to handling, the dough was smooth up to T3, while T4 became sticky and completely broke during slicing.

Texture properties revealed that, compared with the control group, T3 showed a significant increase in bread hardness and gumminess and a decrease in springiness. The addition of wheat bran and oat bran has similarly been reported to significantly increase the hardness and chewiness of bread compared to the control group [29].

Colour analysis indicated that the a* and b* values of the bread crumb increased with higher levels of incorporation. Bread made with 100% wheat flour has been reported to record a maximum L* value of 69.46, which was not significantly different from bread made with 90% wheat and 10% banana flour (65.39) or 95% wheat and 5% aonla powder (67.01) [20]. Previous studies have suggested that the darkening of bread may also result from the Maillard reaction between reducing sugars and proteins, due to the inclusion of fruit juice containing sugar [30, 31, 32].

Finally, sensory analysis revealed that T3 showed good aroma and texture due to the addition of garlic peel and kiwi fruit at the optimum concentration (83% all-purpose flour, 5% oat bran, 9% kiwi fruit and 3% garlic peel). Bread with 10% banana powder has been reported to be more acceptable than bread with 10% aonla powder, which scored poorly [20]. The aonla-powder-incorporated bread showed the lowest scores for taste and flavour, due to an unacceptable acidic taste imparted by the aonla.

Conclusion

The present investigation was carried out to optimise the effective levels of garlic peel and kiwi fruit pulp incorporation in bread. Both garlic peel and kiwi fruit pulp have a plethora of health benefits. It was observed that treatment T3 (83% all-purpose flour, 5% oat bran, 9% kiwi fruit and 3% garlic peel) resulted in better bread formation compared to the other treatments and control.

In comparison to the control, treatment T3 showed a decrease in specific volume and springiness of the bread due to the increased level of the major ingredients. Mineral analysis of the T3 sample bread showed a higher content of major and trace minerals, such as iron and magnesium, than the control bread, which are important for producing the haemoglobin protein in red blood cells and for regulating muscle and nerve function, respectively. Sensory analysis revealed that the T4 sample was least acceptable to the panellists due to its unacceptable texture and bread formation, as shown above. From the above findings, it is concluded that garlic peel and kiwi fruit juice may be applied as a novel constituent for producing high-quality bakery products at an optimal ratio (9:3), especially bread products that provide sufficient nutrient-rich and therapeutic value through food for elderly and sick people.

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Author Contributions
Conceptualisation, Gandepalli Pratap Kumar; Methodology, Dejasvanth S.C.; Research, Dejasvanth S.C.; Data curation, Dejasvanth S.C.; Writing – preparation of the original draft, Dejasvanth S.C.; Review and editing, Mathumathi K ,Kaviya Manikandan and Hareni R.; Supervision, Gandepalli Pratap Kumar. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
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