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Formulation and sensory evaluation of chapati fortified with different vegetable waste powders

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Abstract
The primary objective of this research study is to formulate superior quality wheat flour fortified with different food waste having nutritional profile and to optimize the ratio between wheat flour and different food wastes (potato skin powder, pumpkin peels powder and pumpkin seeds powder) to make chapati by using optimized wheat flour based on sensory evaluation (color, flavor/taste, texture and overall acceptability) as an alternative to the conventional wheat flour. The organoleptic properties of commercially produced control (T_0) and experimental wheat flour (T_1, T_2, and T_3) were assessed by a tasting panel of 50 assessors having deep knowledge of food science sector. The sensory assessment was conducted over a three-day period. Each trait was rated on a 9-point hedonic scale, with 9 being the highest rating and 1 being the lowest. Following a sensory assessment and overall acceptability score, T_2 treatment had a higher score (6.57 ± 0.06^{cb}) than the T_1 score (6.13 ± 0.11^{b}) and T_3 score (6.33 ± 0.02^{dbc}).

Keywords: Bioactive compounds, chapati, food waste, fortified wheat flour, potato skin, pumpkin seed, pumpkin skin, sensory evaluation

1. Introduction

In accordance with Food and agricultural organisation (FAO) it was noticed that one third portion of foods are categorised as food wastage (FAO, 2011) [9] in the form of peels and seeds. Recent studies have asserted that, waste portions of food can be utilised as renewable material as they content bioactive components (Faustino *et al*., 2019; Panzella *et al*., 2020) [10, 17]. Bioactive constituents have elaborated as "natural or synthetic compounds with the capacity to interact with one or more components in the living tissues and exerting a wide range of effects" (Essien *et al*., 2020) [8]. Functional food matrix carries very beneficial bioactive constituents rather than conventional food sources (Guiné *et al*., 2020) [13]. In modern era, health-conscious people accept functional food items along with natural additives which enriches with nutraceutical and confer health edges (Coman *et al*., 2020) [6]. Bioactive components of food wastage are polyphenols, tannin, flavonoids, flavanols, vitamin A and E essential minerals and fatty acids and pigments (Ben-Othman *et al*., 2020) [4]. Wastage chunks of food also have sugar, organic acids, flavor, phytochemicals, enzymes, antimicrobial substances, and fibre (Fleuri and Delgado, 2015) [11].

People are very much habituated to imbibe wheat flour which are available in market. Whole grain cereals, pulses are very much utilised as a source for the development of wheat flour that's why wheat flour is very much expensive. So, this research was carried out to develop chapati from low-cost fortified wheat flour by using food waste (Potato skin powder, pumpkin peels and pumpkin seeds powder).

1.1 Potato peels as food waste

Meta-analysis have shown that, from potato, mass quantity of wastages including peels are generated (Pathak *et al*., 2018) [18]. People does not intake potato skin generally therefore, huge amount of peels are gathered for food processing in recycling areas of food industry. These have enormous health benefits (Benkeblia, 2020; Galhano dos Santos *et al*., 2016) [3, 12]. Potato peels are the very big sources of dietary fibre.

Apart from that, they have secondary metabolites which are regarded as phenolic element like derivatives of hydroxycinnamic acid including chlorogenic S acid, caffeic acid, ρ-coumaric acid, ferulic acid, derivatives of hydroxybenzoic acids like vanillic acid, protocatechuic acid, gallic acid and ρ hydroxybenzoic acid (Akyol *et al*., 2016) [1]. Flavonoid are considered as crucial phenol which convey flavor and color, these are regarded as second rows of phenolic compounds in potato peels including flavonoid, anthocyanin. Furthermore, kaempferol, rutin and quercetin are also present in potato peels. Noteworthy, glycoalkaloids, polysaccharides, protein constituents, micro minerals like vitamins and minerals are also have in these (Bogucka and Elzbieta, 2018) [5].

1.2 Pumpkin peels and seeds as food waste

Pumpkin is very much adaptable vegetable among communities of vegetables. Pumpkin seeds and peels hold lots number of phytochemicals which ameliorate various complications (Sharma *et al*., 2020) [21]. Pumpkin peels possess nutraceuticals which is also utilised as natural medicine. They have very beneficial constituents for instance phenolics, flavonoids, flavones, tocopherol, tocotrienol (Asif *et al*., 2017) [2]. Pumpkin seeds exhibit good antioxidant status (Kvapil *et al*., 2020) [16]. Both have better antibacterial and antifungal compounds, few of these are proteins including α and β, myeloid antimicrobial peptides, apart from that, very new experiment have demonstrated that, protein like Pr-1 shows a strong antifungal activity which have no threatening efficacy on erythrocytes of human (Krimer-Malesevic, 2020) [14].

The main objective of this research study is to formulate superior quality wheat flour that is fortified with various food wastes that have nutritional profiles and to optimise the ratio of wheat flour to various food wastes (potato skin, pumpkin peels, and pumpkin seeds) in order to make chapati using optimised wheat flour based on sensory evaluation (color, flavor/taste, texture, and overall acceptability) as a substitute for traditional wheat flour.

2. Materials and Methods

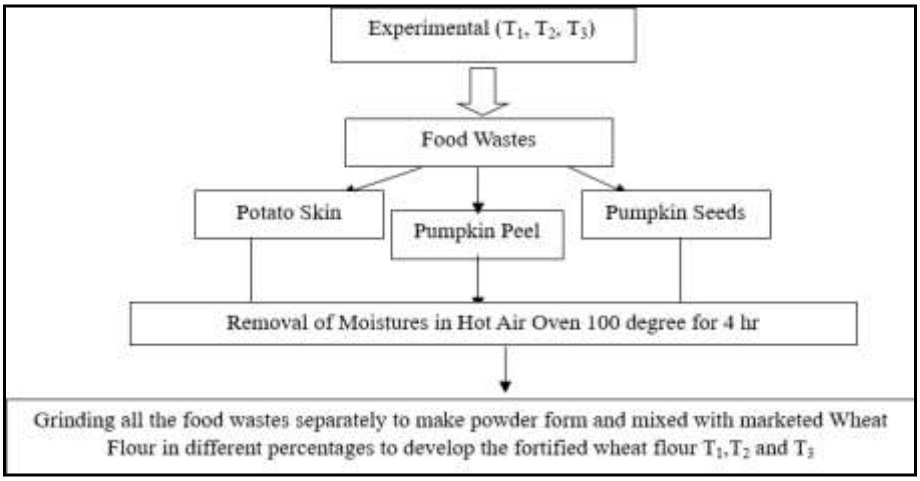
2.1 Collection of food waste

As a raw material, wastes part of potato (Potato peels), pumpkin (pumpkin peels and seeds) was collected from local market of Thakurpukur, Kolkata.

2.3 Preparation of powder from food waste

All of the waste samples were chopped up into tiny bits, then dehydrated at 100 °C for around 4 hours in an air-circulating oven after being rinsed with tap water. After properly removed free water from the sample, mixer grinder was used to prepare powder form.

2.4 Flow chart for development of fortified wheat flour



2.5 Treatment combinations of fortified wheat flour

- T_0 (Control wheat flour without any food wastes).
- T_1 (Wheat Flour-85%, Potato skin powder- 5%, Pumpkin peel powder-5% and Pumpkin seeds powder-5%).
- T_2 (Wheat Flour-91%, Potato skin powder- 3%, Pumpkin peel powder- 3% and Pumpkin seeds powder- 3%).
- T_3 (Wheat Flour- 94%, Potato skin powder- 2%, Pumpkin peel powder- 2% and Pumpkin seeds powder- 2%).

No. of Treatment: 3 +1 =4
No of replication: 03
Total no of trials: 12

2.6 Preparation of newly prepared chapati from fortified wheat flour

After preparation of powder from food wastes, dough was prepared by flowing above maintained treatment combination with adequate purified water. The dough should be well-kneaded and should not be too soft or sticky. Then the dough was being covered for 15 to 20 minutes with a damp cloth so that the gluten can be released and that makes the dough more malleable. Using the gentle hands, the dough has been rolled and dough balls have been made to prepare the chapati.

2.7 Sensory evaluation

A tasting panel made up of 50 judges (ranging in age from 20 to 60; 20 women and 30 men) evaluated the organoleptic qualities of produced control (T_0) and experimental wheat flour (T_1, T_2 and T_3). The sensory evaluation has been triplicated in three days interval. The panelists were asked to assess the product's color, flavor/taste, texture and overall acceptability. All metrics were compared to a control sample that did not include food waste. Each trait was rated on a 9-point hedonic scale, (Wichchukit and O'Mahony, 2015) [24] with 9 being the highest rating and 1 being the lowest. In order to reduce bias and ensure that tasters did not influence one another, standard sensory evaluation techniques were used, as explained by (Watts *et al*., 1989) [23].

2.8 Statistical analysis

To determine the statistical significance of the research data, One-Way Analysis of Variance (ANOVA) technique and

Critical difference (C.D) were used for sensory analysis for newly developed fortified wheat flour chapati. All values are expressed as mean and standard deviation of three parallel measurements.

3. Results

This research study was carried out in the Laboratory of Food and Nutrition (Swami Vivekananda University, Barrackpore, W.B., India) to prepare chapati by using fortified wheat flour from food waste in different percentages.

Table 1: Sensory Evaluation of fortified chapati

Treatment combinations	Color	Flavor/taste	Texture	Overall acceptability
T_0	7.80± 0.05^{a}	6.83±0.12^{a}	7.60±0.10^{a}	7.41±0.06^{a}
T_1	6.30± 0.05^{b}	6.03±0.18^{b}	6.06±0.06^{b}	6.13±0.11^{b}
T_2	7.16±0.08^{ca}	6.20±0.10^{cb}	6.36±0.20^{cb}	6.57±0.06^{cb}
T_3	6.60±0.26^{dbc}	6.20±0.05^{dbc}	6.20±0.05^{dbc}	6.33±0.02^{dbc}

All the test were performed in triplets. Different letter in the same column indicates statistical significance level of $p<0.05$.

4. Discussion

Under the current experiment, locally available food wastes were used as fortificant to make fortified chapati, and their sensory evaluation, and consumer acceptability were assessed.

The mean sensory attributes of the control and newly prepared chapati by using fortified wheat flour are presented in Table 3.1. After sensory evaluation of color score, it was observed that T_2 treatment showed height score compare to the other treatments T_1 and T_3 **(**Figure: 1). It was also observed that the treatment T_0 (7.80±0.05^{a}) was significantly difference from T_1 (6.30±0.05^{b}) and T_3 (6.60±0.26^{dbc}). And insignificantly difference was found between T_0 (7.80±0.05^{a}) and T_2 (7.16±0.08^{ca}). The chapati became darker in color than the unfortified chapati (T_0) with the increase of potato skin, pumpkin peels and seeds concentration in the formulations (Figure: 5). The darker color was expected with the addition of food wastes in the formulations, as these food wastes contain higher concentrations of phytochemicals (Rowayshed *et al*., 2015) [20]. Due to the various phytochemical concentrations of the food wastes used for fortification, a similar color shift trend in cereal bars and cookies were also noted in multiple investigations (Silva *et al*., 2014; Roni *et al*., 2021) [22, 19].

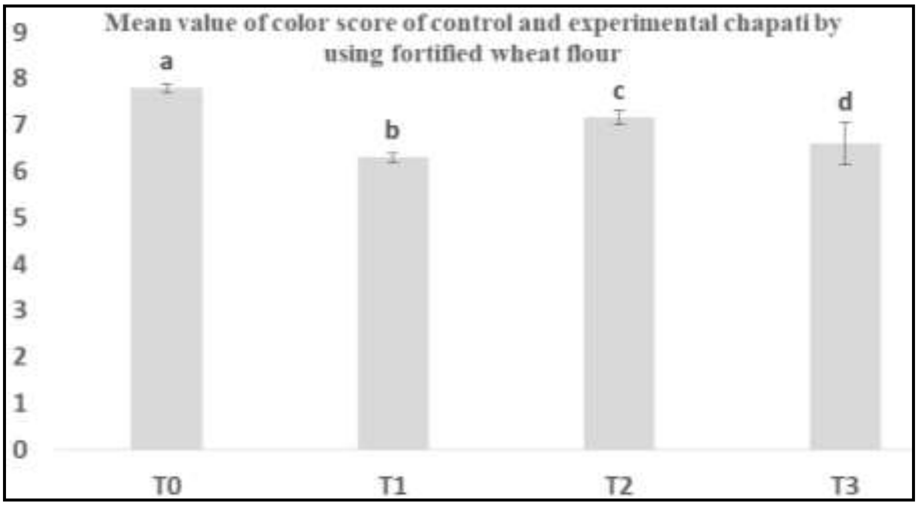


Fig 1: Graphical representation of color score of control and experimental chapati

After sensory evaluation of flavor/taste score, it was observed that T_2 treatment showed higher score compare to the treatments T_1 (Figure: 2). It was also observed that the treatment T_0 (6.83±0.12^{a}) was significantly difference from T_1 (6.03±0.18^{b}), T_2 (6.20±0.10^{cb}) and T_3 (6.20±0.05^{dbc}). And insignificantly difference was found between T_1 (6.03±0.18^{b}) and T_2 (6.20±0.10^{cb}); T_1 (6.03±0.18^{b}) and T_3 (6.20±0.05^{dbc}); T_2 (6.20±0.10^{cb}) and T_3 (6.20±0.05^{dbc}).

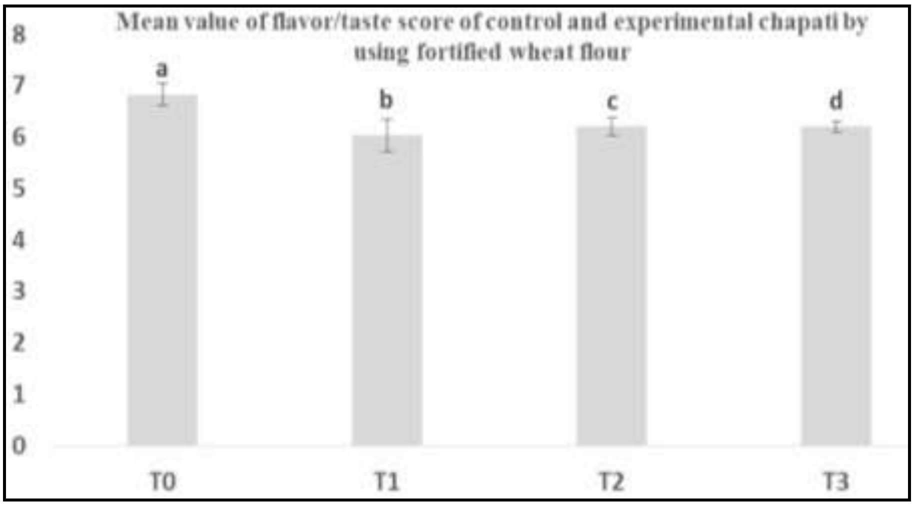


Fig 2: Graphical representation of flavor/taste score of control and experimental chapati

After sensory evaluation of texture score, it was observed that T_2 treatment showed higher score compare to the treatments T_1 and T_3 (Figure: 3). It was also observed that the treatment T_0 (7.60 ± 0.10^{a}) was significantly difference from T_1 (6.06 ± 0.06^{b}), T_2 (6.36 ± 0.20^{cb}) and T_3 (6.20 ± 0.05^{dbc}). And insignificantly difference was found between T_1 (6.06 ± 0.06^{b}) and T_2 (6.36 ± 0.20^{cb}); T_1 (6.06 ± 0.06^{b}) and T_3 (6.20 ± 0.05^{dbc}); T_2 (6.36 ± 0.20^{cb}) and T_3 (6.20 ± 0.05^{dbc}).

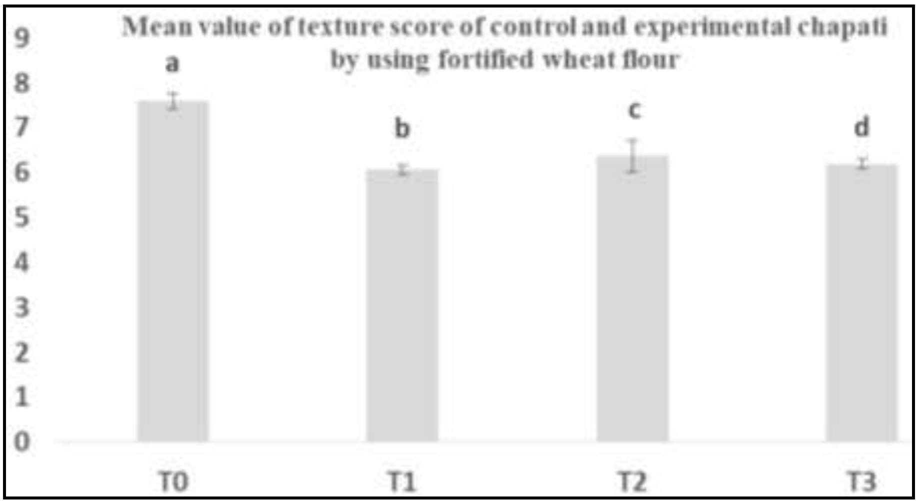


Fig 3: Graphical representation of texture score of control and experimental chapati

After sensory evaluation of overall acceptably score, it was observed that T_2 treatment showed higher score compare to the treatments T_1 and T_3 (Figure: 4). It was also observed that the treatment T_0 (7.41 ± 0.06^{a}) was significantly difference from T_1 (6.13 ± 0.11^{b}), T_2 (6.57 ± 0.06^{cb}) and T_3 (6.33 ± 0.02^{dbc}). And insignificantly difference was found between T_1 (6.13 ± 0.11^{b}) and T_3 (6.33 ± 0.02^{dbc}); T_2 (6.57 ± 0.06^{cb}) and T_3 (6.33 ± 0.02^{dbc}).

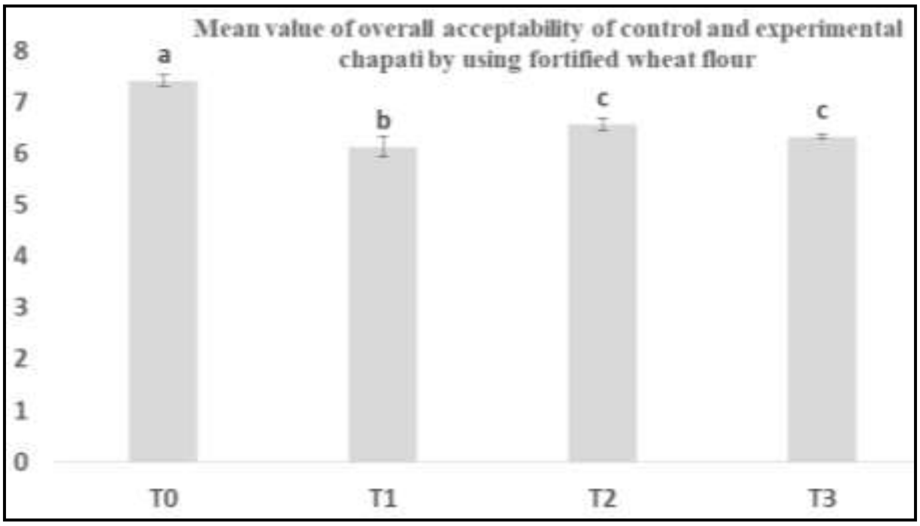


Fig 4: Graphical representation of overall acceptability of control and experimental chapati

Overall, the sensory evaluations showed that, when compared to the chapati samples containing food waste, the control chapati sample had the highest customer acceptability. The darker color of the fortified chapati may be the cause of the lower consumer approval value. These results are in line with past studies that showed a slight decline in overall acceptability as the amount of *Moringa oleifera* leaf powder increased (El-Gammal *et al*., 2016; Roni *et al*., 2021) [7, 19]. However, the 3% potato skin powder, pumpkin peels powder, and pumpkin seeds powder fortified chapati received ratings that were nearly identical to those of the unfortified control and were statistically comparable.

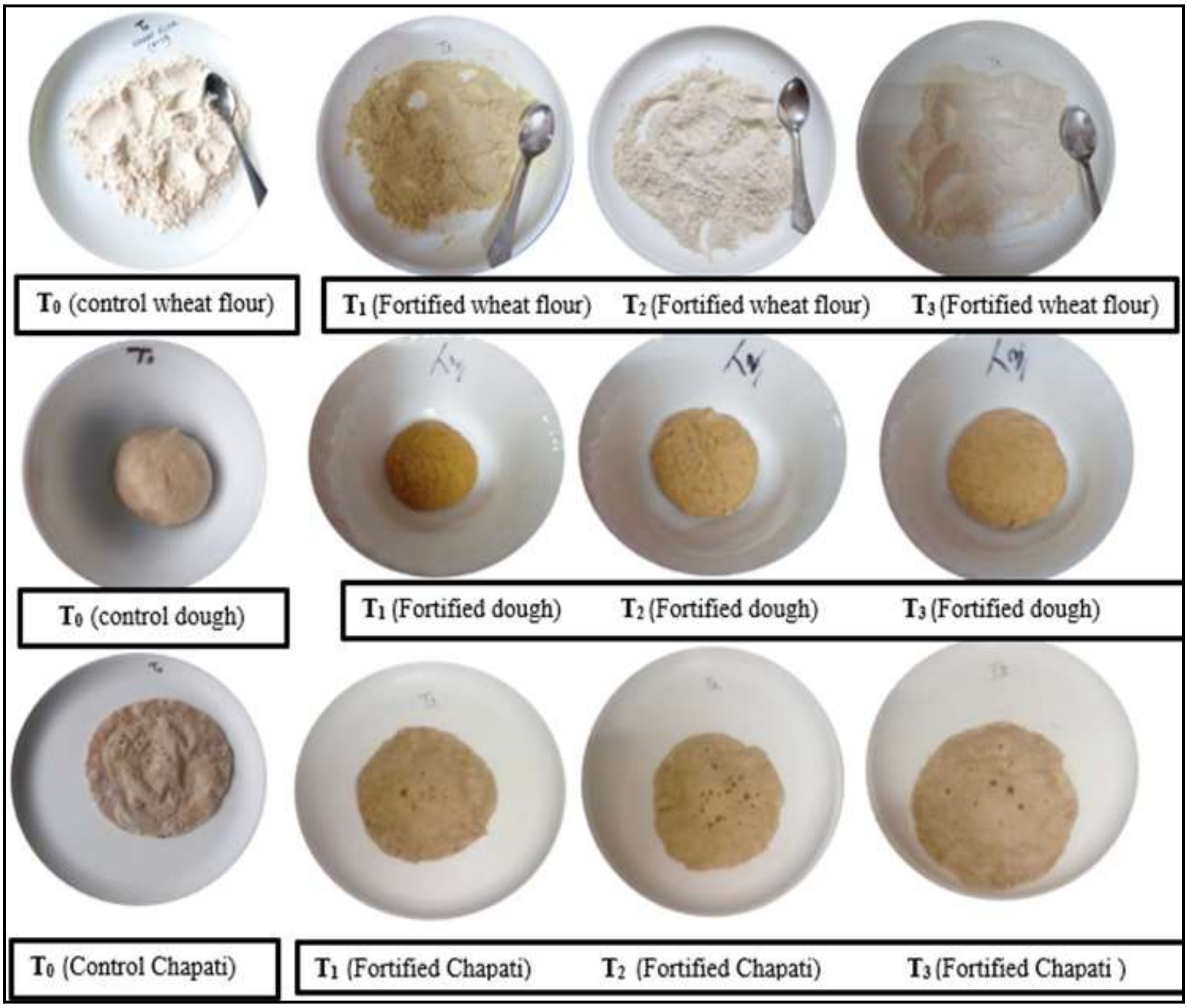


Fig 5: Pictorial view of control and experimental chapati

5. Conclusions

Sensory analysis of this research revealed that the acceptance of the chapati declined as the percentage of food wastes increased, but the chapati having 3% potato skin powder, 3% pumpkin peels powder, and 3% pumpkin seeds powder were nearly as palatable as the control. Overall, the research demonstrates that newly prepared chapati with 3% potato skin powder, 3% pumpkin peels powder and 3% pumpkin seeds powder can contribute to better food and nutritional security.

This newly developed chapati by using fortified wheat flour is relatively less expensive because food wastes (Like potato skin powder, pumpkin peel powder and pumpkin seeds powder) were used. Many researchers already revelled that the used food wastes have many bioactive compounds so, the newly developed chapati will be helpful for human health. Therefore, it can be said that this study will provide new avenues and research for the future. Additionally, adding potato skin powder, pumpkin peels powder, and pumpkin seeds powder when making chapati will help to encourage the recovery of food waste for the manufacturing of food products with additional value.

6. Acknowledgments

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7. Conflicts of Interest

The authors declare no conflict of interest.

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