Author's details are given below
the reference section

Development of major millets (Finger, Pearl, Sorghum) bakery products and its quality evaluation

Vipul Chaudhary, Vivak Kumar, Vijay Kumar Singh, Harsh Prakash Sharma, Shashank Verma, Ankur Mahendra Arya, Arjun Sanjay Paul, Sunil and Vaishali

Abstract
The study is aimed to develop multi-millets bakery products based on the multiple health benefits of the rarely used millets like pearl millet (Bajra), finger and sorghum (Jowar). In the present study, an attempt has been made to standardize "Multi Millet Bakery Products" with selected millets are pearl millet flour, sorghum flour, whole wheat flour. The product were organoleptically evaluated for the colour, appearance, texture, taste flavour and overall acceptability using Nine point Hedonic scale. Sensory evaluation revealed highest score for Overall acceptability for the treatment T_2 that is at 30 percent enrichment. It can be therefore concluded that Multi millets flour can be suitably incorporated in various bakery products. With increase in the percentage of millets flour the increase in the proximate composition, minerals and nutrients were observed. Millets improved the chemical properties of the millet flour and increase in the mineral content of millet flour as compared to Wheat flour was recorded. Resulting gluten free millets cookies and bread could not only contribute to celiac patients but also to the growing health conscious population.

Keywords: Finger, pearl, sorghum flour, cookies and bread

1. Introduction

Millets are known as 'Gods own crops' belongs to family Gramineae, are one of the oldest, small-sized cereal grains known to human from pre-historic time to be used as bird and animal feed (Kulkarni, *et. al.,* 2021) [5]. It has proved to have high nutritional as well as medicinal properties reported (Yang *et al.,* 2012) [15]. Millets consist of slow-releasing carbohydrates and thus lowers the risk of diabetes. Also found to be rich in dietary fibres, minerals like iron, magnesium, phosphorous and potassium (Michaelraj and Shanmugam, 2013) [7]. Millets are gluten-free hence best suited for celiac patients (Thompson, 2009) [14]. India is the foremost producer of minor millets namely, Finger millet, Kodo millet, Barnyard millet, Pearl millet and Little Millet (Majumdar *et al.,* 2006) [6].

Millets are categorized as major and minor millets. Sorghum, Finger and Pearl millet are classified as major millets and all other millets are classified as minor millets. Nine species of millets are grown around the world (Sade, 2009) [12]. Among the nine, five millet types are commonly cultivated which include, proso millet (*Panicum miliaceum*), foxtail millet (*Setaria italica)*, finger millet (*Eleusine coracana*), pearl millet (*Pennisetum typhoideum*) and barnyard millet (*Eichinochloa frumentacea*), (Ravindran, 1991) [11].

Millets provide a wide range of health benefits and they are a good source of energy, proteins, minerals and vitamins. Millet proteins are a good source of essential amino acids except lysine and threonine but contain higher amount of methionine. Millets contain abundant phytochemicals and micronutrients and due to these nutritional benefits, millets are termed as "Nutri-Cereals" (Singh *et al.,* 2012) [13].

Nowadays, bakery products account for a major part of the processed food market and this industry is rapidly changing with advancements in nutraceuticals and new product developments (Kotsianis *et al.,* 2002) [4].

Corresponding Author:
Shashank Verma
Research Scholar, Department of Processing and Food Engineering, Mahamaya College of Agricultural Engineering and Technology Ambedkar Nagar, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

The bakery industry and its products should comply with consumers' healthy eating habits and to accomplish this goal the modernization of bakery plants and new product developments are necessary (Kotsianis *et al.,* 2002) [4].

Cookies are staple ready to eat food being consumed among all people with no regard to any demographic concerns like age, financial status or geographical boundaries. Easy availability at any part of the state urban or rural, nutritious features, less cost etc has made the cookies well known snacks. United States of America and India takes the first two position respectively in production of cookies and biscuits and India is third largest consumer of these products. In the 2020 it is estimated that the per capita consumption of cookies worldwide will be 3.0 kg annually (Gunaseelan and Arun, 2021) [2].

Bread is a staple food prepared from dough of flour and water, usually by baking. Throughout recorded history it has been a prominent food in large parts of the world and is one of the oldest man-made foods, having been of significant importance since the dawn of agriculture (Mounika and Sireesha, 2021) [8]. Bread is a food consumed all over the world by all age people. It is prepared from white flour, yeast, sugar, fat, salt, water, etc., by a series of operations like mixing, kneading, fermentation, proofing and baking (Dewettinck *et al.,* 2008) [3].

However, studies carried out to use millets in bakery products are very limited. The main objective behind replacing wheat flour with millets in bakery products is to add more functional and nutritional value to the bakery products and at the same time help in promoting locally grown crops such as millets to enhance farmers' life in many regions of the world. Adding such replacements will affect the baking quality and in-turn the overall consumer's acceptance. Identifying the right proportion of such replacement products in the baking industry has always been a major challenge (Murugesan, 2014) [9].

The study is aimed to develop multi-millets bakery products based on the multiple health benefits of the rarely used millets like pearl millet (Bajra) and sorghum (Jowar). In the present study, an attempt has been made to standardize "Multi Millet Bakery Products" with selected millets are pearl millet flour, sorghum flour, whole wheat flour**,** Jaggery, yeast, butter, and baking essentials like baking powder.

2. Materials and Methods
2.1 Procurement and Processing of ingredients
Raw ingredients like refined wheat flour, Multi Millets (Finger, Pearl and Sorghum) flour, ghee, jaggery, sugar and salt etc. were purchased from the local market.

2.2 Development of bakery products from multi millets flour
The Major Millets (Finger, Pearl and Sorghum) Flour were used for the preparation of baked products by utilizing Multi Millets Flour (Finger, Pearl and Sorghum) in three proportion i.e.0%, 15% and 30% in standardized recipes. Refined flour was replaced with Multi Millets Flour for the preparation of cookies and bread. These products were prepared in three different proportions, T_0 contained 0% Multi Millets Flour, T_1 contained 15% Multi Millets Flour (Sorghum 5%, Finger 5%, Pearl 5%) and T_2 contained 30% Multi Millets Flour (Sorghum 10%, Finger 10%, Pearl 10%).

Treatments
T_0 - 0% Multi Millets Flour & 100% Wheat Flour

T_1 - 15% Multi Millets Flour (Sorghum 5%, Finger 5%, Pearl 5%) & 85% Wheat Flour.

T_2 - 30% Multi Millets Flour (Sorghum 10%, Finger 10%, Pearl 10%) & 70% Wheat Flour.

2.2.1 Development of cookies
Wheat flour was mixed with multi millets flour and cookies were prepared according to the following treatments using the recipe described below.

Ingredients

Wheat & Millets Flour	T_0, T_1 & T_2
Jaggery	55g/100 g
Ghee	40g/100 g
Baking Powder	1 g/100g
Milk powder	10 g/100g

Methods
Proper creaming of sugar and hydrogenated vegetable oil was done. Creamed material was mixed with multi millets flour, wheat flour, milk powder and baking powder. All the materials were mixed by hand until a firm dough was formed. The dough was rolled out in a baking tray and cut into round in shape with a cookie cutter. The cookies were placed in greased aluminum trays and baked in deck oven at 150ºC upper temperature and 150ºC lower temperature for 18 minutes. The cookies were kept out from oven and cooled at room temperature. At last, the cooled cookies were packed and stored for further studies at ambient condition.

2.2.2 Development of bread
Wheat flour was mixed with multi millets flour and bread were prepared according to the following treatments using the recipe described below.

Ingredients

Wheat & Millets Flour	T_0, T_1 & T_2
Sugar	4.5g/100 g
Yeast	2.5g/100 g
Ghee	12g/100g
Salt	4.5g/100g

Methods
Activated yeast with lukewarm water and small amount of sugar. Kneaded flour and multi millets flour into soft dough with water. Kept dough to ferment for 3 hours at 27^0C, added fat and kneaded vigorously to get smooth soft dough. Kept for 30 minute, molded in the tin at 35 ^{0}C for 50 minute. The tin were placed in deck oven at 230 ^{0}C for 15 minutes. The bread were kept out from oven and cooled at room temperature.

2.3 Methods of Analysis
The analysis of different properties of millets cookies were and bread done to produce a commercially valuable product with good quality. Analysis of the product also aided to be aware of the relative changes in the quality factors influenced by different multi millets (finger, pearl, sorghum) bakery products.

2.3.1 Chemical analysis of multi millets bakery products
The millets cookies and bread the best acceptable products were analyzed for proximate composition, moisture content, ash content, protein content, fat content, fiber content and

carbohydrates using standard methods for all the chemical parameters in triplicate.

2.3.2 Organoleptic evaluation of multi millets bakery products

Organoleptic evaluation of Development of products from multi millets bakery and evaluation was carried out in this experiment. The 9 point Hedonic Scale was used to compare the control with the formulated samples. Sensory evaluation was conducted in sensory evaluation laboratory, Department of agricultural engineering (Process and Food Engineering). The panelists were selected solely on the basis of interest, time available and lack of allergies to food ingredients used in study. On every occasion, the panelists were provided with coded disposable paper cups containing the sample under investigation. Sensory evaluation was carried out under ambient conditions. A comfortable area without distractions (isolated booths) under fluorescent lighting and controlled temperature was used. Water was supplied to clean the pallets between the evaluations of two samples. Samples were tested for different parameters like color, taste, texture, flavor, and overall acceptability. All these tests including the testing for consumer acceptance was done by sensory panelist according to 9 point hedonic scale for sensory evaluation as described by (Peryam and Giradot 1952) [10].

3. Results and Discussion

Bakery products have become popular across different sections of populations both in urban and rural India. Among bakery products bread or cookies are the most popular because of various appealing factors and excellent storage qualities, besides universal availability. The results of the experiments conducted on development and quality evaluation and sensory analysis was analyzed at different treatments using standard procedures. The quality of the fresh Millets cookies and Bread were evaluated on the basis of Chemical characteristics like moisture content, ash content, fat content, protein content and fiber content, secondly the sensory characteristic were reported on the basis of color, flavor, taste, texture and overall acceptability. All the four samples were packed in the Glass Jar were analyzed after the preparation and during the ambient storage. The results obtained were represented and discussed below.

3.1 Proximate composition of cookie samples

Proximate composition i.e. the moisture, protein, fat, ash, fiber and total carbohydrates content of cookies prepared by using multi millets flour have been depicted in Table 1.

The fiber content of multi millets flour cookie sample T_1 and T_2 were found to 3.02% and 4.01% respectively. The fiber content of the control sample T_0 was found to be 1.34% which was lowest as compared to the cookie prepared from multi millets flour. The ANOVA for fiber content of multi millets

flour cookie variations T_0, T_1, and T_2 samples. It was observed that treatments effects on fiber content were found significant at 5% level of significance.

The ash content of the multi millets flour cookie sample T_1 and T_2 were found to 0.90% and 0.75% respectively. While the ash content of control sample T_0 was found to be 1.02%. The lowest ash content was found in sample T_2 i.e 0.75% as compared to the rest of samples T_1 and highest ash content in the sample T_0. Ash content of cookie decreased with the incorporation of multi millets flour. The ANOVA for ash content of multi millets flour cookie variations T_0, T_1, and T_2 samples. It was observed that treatments effects on ash content were found significant at 5% level of significance.

The fat content of the multi millets flour cookie sample T_1 and T_2 were found to 23.03% and 22.02% respectively. The fat content of the control sample T_0 was found to be 24.96% which was highest as compared to the cookie prepared from multi millets flour. Fat content of cookie decrease with the incorporation of multi millets flour. The ANOVA for fat content of multi millets flour cookie variations T_0, T_1, and T_2 samples. It was observed that treatments effects on fat content were found significant at 5% level of significance.

The protein content of the multi millets flour cookie sample T_1 and T_2 were found to 10.85% and 12.09% respectively. While the protein content of the control cookie sample was found 8.41%. The cookie sample T_2 had highest protein content and it increased gradually with the increase in multi millets flour content in samples. The ANOVA for protein content of multi millets flour cookie variations T_0, T_1, and T_2 samples. It was observed that treatments effects on protein content were found significant at 5% level of significance.

The moisture content of the multi millets flour cookie sample T_1 and T_2 were found to 2.70% and 2.40% respectively. The control sample made of 100% of wheat flour had highest moisture content while the sample made of 30% of multi millets flour had lowest moisture content. The higher moisture content moisture content in cookie samples were due to the large amount of water required in optimum dough preparation. The ANOVA for moisture content of multi millets flour cookie variations T_0, T_1, and T_2 samples. It was observed that treatments effects on moisture content were found significant at 5% level of significance

The total carbohydrates of the multi millets flour cookie sample T_1 and T_2 were found to 52.03% and 54.06% respectively. The total carbohydrates of the control sample T_0 was found to be 50.69% which was lowest as compared to the cookie prepared from multi millets flour. Increase in total carbohydrates of multi millets flour incorporated cookie was observed with the increase in incorporation of multi millets flour. The ANOVA for total carbohydrates of multi millets flour cookie variations T_0, T_1, and T_2 samples. It was observed that treatments effects on total carbohydrates were found significant at 5% level of significance

Table 1: Proximate composition of multi millets cookies samples

Treatment	Moisture Content (%)	Protein Content (%)	Fat Content (%)	Fiber Content (%)	Ash Content (%)	Total Carbohydrate (%)
T_0	3.20±0.046	8.41±0.003	24.96±0.015	1.34±0.016	1.02±0.010	50.69±0.020
T_1	2.70±0.042	10.85±0.002	23.03±0.014	3.02±0.011	0.90±0.014	52.03±0.023
T_2	2.40±0.040	12.09±0.001	22.02±0.012	4.01±0.013	0.75±0.013	54.06±0.024
Mean	2.76±0.042	10.45±0.002	23.33±0.013	2.78±0.013	0.72±0.012	52.26±0.021
S.Em±	0.02	0.02	00.02	0.02	0.02	0.02
CD(P=0.05)	0.1	0.4	0.5	0.5	0.2	0.4

3.2 Proximate composition of bread samples

Proximate composition i.e. the moisture, protein, fat, ash, fiber and total carbohydrates content of bread prepared by using multi millets flour have been depicted in Table 2.

The fiber content of multi millets flour bread sample T_1 and T_2 were found to 1.42% and 2.10% respectively. The fiber content of the control sample T_0 was found to be 0.90% which was lowest as compared to the bread prepared from multi millets flour. The Fiber content of bread ranged from 0.90 to 2.10. This increase in fiber content was due to incorporation of multi millets flour. The ANOVA for fiber content of multi millets flour bread variations T_0, T_1, and T_2 samples. It was observed that treatments effects on fiber content were found significant at 5% level of significance.

The ash content of the multi millets flour bread sample T_1 and T_2 were found to 0.96% and 0.65% respectively. While the ash content of control sample T_0 was found to be 1.45%. The lowest ash content was found in sample T_2 i.e 0.65% as compared to the rest of samples T_1 and highest ash content in the sample T_0. The ash content of bread ranged from 0.65 to 1.45% respectively. Ash content of bread decreased with the incorporation of multi millets flour. The ANOVA for ash content of multi millets flour bread variations T_0, T_1, and T_2 samples. It was observed that treatments effects on ash content were found significant at 5% level of significance.

The fat content of the multi millets flour bread sample T_1 and T_2 were found to 3.01% and 2.56% respectively. The fat content of the control sample T_0 was found to be 4.00% which was highest as compared to the bread prepared from multi millets flour. The fat content of bread varied from 2.56 to 4.00%. Fat content of bread decrease with the incorporation of multi millets flour. The ANOVA for fat content of multi millets flour bread variations T_0, T_1, and T_2 samples. It was observed that treatments effects on fat content were found significant at 5% level of significance.

The protein content of the multi millets flour bread sample T_1 and T_2 were found to 12.35% and 13.10% respectively. While the protein content of the control bread sample was found 11.96%. The bread sample T_2 had highest protein content and it increased gradually with the increase in multi millets flour content in samples. So, with the incorporation of multi millets flour protein content increased in the bread samples as compared to the control samples. The ANOVA for protein content of multi millets flour bread variations T_0, T_1, and T_2 samples. It was observed that treatments effects on protein content were found significant at 5% level of significance.

The moisture content of the multi millets flour bread sample T_1 and T_2 were found to 33.01% and 34.01% respectively. The control sample made of 100% of wheat flour had highest moisture content while the sample made of 30% of multi millets flour had lowest moisture content. The higher moisture content moisture content in bread samples were due to the large amount of water required in optimum dough preparation. The ANOVA for moisture content of multi millets flour bread variations T_0, T_1, and T_2 samples. It was observed that treatments effects on moisture content were found significant at 5% level of significance

The total carbohydrates of the multi millets flour bread sample T_1 and T_2 were found to 46.89% and 50.06% respectively. The total carbohydrates of the control sample T_0 was found to be 44.01% which was lowest as compared to the bread prepared from multi millets flour. Bhadra (1997) [1] total carbohydrate content of bread prepared by incorporating multi millets flour varied from 44.01 to 50.06%. Increase in total carbohydrates of multi millets flour incorporated bread was observed with the increase in incorporation of multi millets flour. The ANOVA for total carbohydrates of multi millets flour bread variations T_0, T_1, and T_2 samples. It was observed that treatments effects on total carbohydrates were found significant at 5% level of significance

Table 2: Proximate composition of multi millets bread samples

Treatments	Fiber content (%)	Ash content (%)	Fat content (%)	Protein content (%)	Moisture content (%)	Total carbohydrates (%)
T_0	0.90±0.012	1.45±0.010	4.00±0.011	11.100.004	32.01±0.036	44.01±0.019
T_1	1.42±0.011	0.96±0.009	3.01±0.013	12.050.002	33.01±0.040	46.89±0.024
T_2	2.10±0.015	0.65±0.014	2.56±0.012	13.000.006	34.01±0.043	50.06±0.022
Mean	1.47±0.013	1.02±0.013	3.19+0.012	12.050.004	33.01±0.039	46.98±0.022
S.Em±	0.02	0.02	0.01	0.01	0.02	0.02
CD(P=0.05)	0.05	0.06	0.05	0.05	0.56	0.14

3.3 Sensory evaluation of cookie samples
Sensory characteristics of the all four samples were determined by taking the sensory Attributes flavour, Crispiness, colour, taste, texture and overall acceptability. Sensory attributes of all kind of cookies samples were evaluated in fresh condition. Hedonic rating test method was used for the evaluation of different samples in fresh condition and in stored condition had been presents in table 3.

The study was conducted under fresh condition. The results of sensory characteristics of cookie samples have been presented in Table 3. The measurements of different attributes, describing quality were respectively. Different sensory attribute were evaluated in fresh condition. Fresh condition the flavor scores of cookies samples T_0, T_1, and T_2 were found to be 7.2, 7.9 and 8.0 and color scores were found to be 7.2, 7.4 and 7.9 and taste scores were found to be 7.3, 7.8 and 8.3 and crispiness scores were found to be 7.4, 7.9 and 8.1 and texture scores were found to be 7.3, 7.7 and 7.6 respectively.

The flavor of the cookie samples were perceived to be desirable by the panelists and therefore the score awarded was beyond "like very much" range. Color of all cookie samples was also acceptable to the panel. The taste of cookie samples was sweet which resembled to one of the four basic tastes namely sweet, bitter and sour.

The overall acceptability of the cookie samples were perceived to be desirable by the Panelists and therefore the score awarded was beyond "like very much" range. The cookie sample T_2 was more acceptable than other cookie samples.

Table 3: Evaluation of sensory attributes of cookie samples

Sample Code	Colour	Crispiness	Flavour	Taste	Texture	Overall Acceptability
T_0	7.2	7.4	7.2	7.3	7.3	7.3
T_1	7.4	7.9	7.9	7.8	7.7	7.7
T_2	7.9	8.1	8.0	8.3	7.6	8.0

3.4 Sensory evaluation of bread samples
Sensory characteristics of the all bread samples were determined by taking the sensory attributes flavour, colour, taste, texture and overall acceptability. Sensory attributes of all kind of samples were evaluated in fresh condition. Hedonic rating test method was used for the evaluation of different samples in fresh condition had been presents in Table 4.

The study was conducted under fresh condition. The results of sensory characteristics of bread samples have been presented in Table 4 the measurements of different attributes, describing quality were respectively. Different sensory attribute were evaluated in fresh condition. Fresh condition the flavor scores of bread samples T_0, T_1, and T_2 were found to be 6.83, 7.30 and 7.90 and colour scores were found to be 7.15, 7.80 and 7.95 and taste scores were found to be 6.60, 7.50 and 6.90 and texture scores were found to be 6.70, 6.75 and 6.90 respectively.

The overall acceptability of the bread samples were perceived to be desirable by the panelists and therefore the score awarded was beyond "like moderately" range. The bread sample T_2 was more acceptable than other bread samples.

Table 4: Evaluation of sensory attributes of bread samples

Sample code	Colour	Flavour	Taste	Texture	Overall acceptability
T_0	7.15	6.83	6.60	6.70	6.82
T_1	7.80	7.30	7.50	6.75	7.33
T_2	7.95	7.90	6.90	6.90	7.41

4. Conclusion
It is concluded that bakery products prepared from multi millets flour was acceptable at all three levels-0, 10 and 30 percent multi millets flour samples. The multi millets flour was used for the preparation of Cookie and bread. Cookie and bread prepared by incorporating 30% multi millets flour contained significantly higher Quality parameters, moisture, ash, protein, fat, fiber and total carbohydrates as compared to the control. In cookie and bread the highest score all the sensory parameters was obtained T_2 - 30% Multi millets flour. The overall acceptability of the cookie and bread samples were perceived to be desirable by the panelists and therefore the score awarded was beyond "like moderately" range. The cookie and bread samples T_2 was more acceptable than other cookie and bread samples. Addition of multi millets flour increased the nutrient density of the all products as compared to the control. The study thus indicated that products prepared by incorporating multi millets flour were sensory and nutritional value superior than control products and could be stored safely.

5. References
1. Bhadra S, Sen SK. Studies on the developmental physiology of bael (*Aegle Marmelos* Correa) fruit var. kalyani selection-I. Prog Hort. 1997;29(3-4):135-137.
2. Gunaseelan D, Arun A. Development and shelf life assessment of millet cookies by means of nutritional and sensory evaluation characteristics. Res J Pharm Tech. 2021;14(3):1482-1486. DOI: 10.5958/0974-360X.2021.00263.8
3. Dewettinck K, Bockstaele VF, Kuhne B, Walle VDD, Courtens TM, Gellynck X. Nutritional value of cookie: Influence of processing, food interaction and consumer perception. J Cereal Sci. 2008;48:243-257.
4. Kotsianis IS, Giannou V, Tzia C. Production and packaging of bakery products using MAP technology. Trends Food Sci Technol. 2002;13(9-10):319-324.
5. Kulkarni DB, Sakhale BK, Chavan RF. Studies on development of low gluten cookies from pearl millet and wheat flour. Food Res. 2021;5(4):114-119.
6. Majumdar TK, Premavalli KS, Bawa AS. Effect of puffing on calcium and iron contents of Ragi varieties and their utilization. J Food Sci Technol. 2006;42(5):542-545.
7. Michaelraj JS, Shanmugam A. A study on millets based cultivation and consumption in India. Int J Marketing Financ Serv Manage Res. 2013;4(2):49-58.
8. Mounika D, Sireesha G. Development of Multi Millet Cookie with Pearl Millet and Sorghum Millet. Wesleyan J Res. 2021;14(80), ISSN: 0975-1386.
9. Murugesan R. Use of millets for partial wheat replacement in bakery products. A Thesis Submitted to McGill University in partial fulfillment of the requirements for the degree of Doctor of Philosophy. 2014.
10. Peryam DR, Girardot NF. Advanced taste test method. Food Eng. 1952;24:58-61.
11. Ravindran G. Studies on millets: Proximate composition, mineral composition, and phytate and oxalate contents. Food Chem. 1991;39(1):99-107.
12. Sade FO. Proximate, antinutritional factors and functional properties of processed pearl millet (*Pennisetum glaucum*). J Food Technol. 2009;7(3):92.
13. Singh K, Mishra A, Mishra H. Fuzzy analysis of sensory attributes of cookie prepared from millet-based composite flours. LWT - Food Sci Technol. 2012;48(2):276-282.
14. Thompson T. The nutritional quality of gluten free foods. In: Gallagher E, Ed. Gluten-free food. The Authors. Published by Rynnye Lyan Resources science and technology, p. 42-51. E-ISSN: 2550-2166, Oxford, UK: John Wiley and Sons. https://doi.org/10.1002/9781444316209.ch4
15. Yang X, Wan Z, Perry L, Lu H, Wang Q, Hao C, *et al*. Early millet use in Northern China. Proc Natl Acad Sci. 2012;109(10):1-5. https://doi.org/10.1073/pnas.111543010

Author's details
Vipul Chaudhary
Assistant Professor, Department of Processing and Food Engineering, Mahamaya College of Agricultural Engineering and Technology Ambedkar Nagar, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Vivak Kumar
Professor, Department of Agricultural Engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Vijay Kumar Singh
Associate Professor, Department of Processing and Food Engineering, Mahamaya College of Agricultural Engineering and Technology Ambedkar Nagar, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Harsh Prakash Sharma
Associate Professor, Department of Food and Nutrition, Babasaheb Bhimrao Ambedkar University, Satellite Center Amethi, Uttar Pradesh, India

Shashank Verma
Research Scholar, Department of Processing and Food Engineering, Mahamaya College of Agricultural Engineering and Technology Ambedkar Nagar, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Ankur Mahendra Arya
Department of Agricultural Engineering, Raja Balwant Singh College of Agriculture Bichpuri, Agra, Uttar Pradesh, India

Arjun Sanjay Paul
Assistant Professor, Department of Renewable Energy Engineering, Mahamaya College of Agricultural Engineering and Technology Ambedkar Nagar, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Sunil
Assistant Professor, School of Agricultural Sciences and Engineering IFTM University, Moradabad, Uttar Pradesh, India

Vaishali
Assistant Professor, Department of Agricultural Engineering, National Post Graduate College Barhalganj, Gorakhpur, Uttar Pradesh, India