Development and Quality Evaluation of Air Fried Multi Millet Tortilla Chips

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ABSTRACT

The current study was aimed to optimize the process for preparation of multi millet tortilla chips. As nowadays people have become more health conscious due to changing lifestyles, detailed research was carried out to develop the multi millet tortilla chips to meet the needs of consumer. Ingredients such as Masa flour, Finger millet, Sorghum, Sesame seeds and seasoning were utilized as raw materials for preparation of multi millet tortilla chips. Optimization of Control sample, Finger millet and sorghum was done. Unlike the tortilla chips available in the market, these multi millet tortilla chips are gluten free and air fried which provides us with a healthy alternative to deep fried tortilla chips. Physical parameters such as texture, colour, thickness, proximate analysis and microbial analysis of formulated tortilla chips were carried out.

Key words**:** *Multi millet Tortilla snack, Gluten free, Masa flour, Air frying*

1.INTRODUCTION

Snack industry is a globally accelerated due to many reasons such as changing lifestyle, increasing concerns for health, innovation and development in agricultural sector concerning grains and millets (Nisha Chhabra, *et al*.,2017). Snacking helps in controlling hunger and may help reduce excess calorie intake. On the other hand, it can lead to obesity, diabetes, cardiovascular diseases, and hypertension, if consumed uncontrollably and prepared with unhealthy ingredients (Arora Mehak; *et al*.,2020). Tortilla chips are a product of nixtamilized maize grains which give unique flavour, taste, and odour to the product. A tortilla is a flat, round, unfermented bread produced from wheat (Tritium aestivum L.) flour, or cooked corn (Zea mays L) and lime. Convenient and functional nixtamalized corn or masa flour is extensively used to produce products such as corn tortillas, taco shells, tostadas, tamales, corn chips, and tortilla chips (Serna Saldivar *et al* 1990) and extruded snacks. Masa flours are typically produced from whole kernel corn that has been cooked in a lime (calcium hydroxide) solution. After cooking, corn is washed to remove excess lime and loose pieces of pericarp. It is then stoneground or hammer-milled and dried in large continuous tunnel driers or drying towers. Less commonly, whole kernel corn is rapidly dried in continuous dryers. The dried material is hammer milled and sieved. Finger millet often (Ragi), is versatile source of carbohydrate, protein and mineral that is comparable to other common cereal grains It contains protein ranging from 6-14 per cent, fat 1-1.4 per cent, dietary fibre 11.5 g/100g, carbohydrates 72 g/ 100g and energy around 1350 to 1450 kJ (Anonymous, 1996). The calcium content is higher than all cereals (370 mg/100 g). Ragi is considered to be ideal food for diabetic individuals due to its low sugar content and slow release of glucose/sugar in the body (G.H. ATHAWALE *et al*., 2015). The basic nutrient content of sorghum (protein, fat, carbohydrate, crude fiber, ash, and energy) is able to compete with other foodstuffs, such as rice, corn, wheat, and millets. (P. Ashwitha Reddy *et al*.,2019). Hot air frying is a new technique to get fried products through direct contact between an external emulsion of oil droplets in hot air and the product into a frying chamber. (Shaker *et al.,*2014). So to make tortilla chips a healthier snack hot air frying was employed.

2.MATERIAL AND METHOLOGY

Masa flour, finger millet flour, sorghum flour, sesame seeds, salt, black pepper powder, chilli flakes, peri-peri seasoning masala were used.

2.1 METHODOLOGY OF TORTILLA SNACK

Mixing of dry ingredients

Addition of warm water

Kneading

Conditioning

Sheeting

Die cutting

Air Frying (160℃ for 11 mins)

Cooling

Packaging

Fig -1Process flowsheet for the preparation of multi millet tortilla snack with slight modification (Giram, K. K *et al*., (2018).

Dry ingredients such as Masa flour, finger millet flour, sorghum flour, sesame seeds, salt, chilli flakes, peri-peri seasoning masala. were mixed. Warm water was added to prepare a dough. The dough was kept for conditioning at room temp for 30 min. The dough was sheeted for about 2 mm thickness and it was die cut into a triangular shape. The prepared tortillas were air fried at 160℃ for 11 mins. It was allowed to cool and packed in an airtight container.

Fig-2 prepared tortilla chips

2.2 Optimization of control Sample was carried out by varying masa flour and water proportion

Ingredients	Samples		
	A	B	**C**
Water (%)	55	60	**50**
Masa Flour (%)	45	40	**50**

Table- 1. Optimization of Masa Flour and Water

Firstly, optimisation of masa flour for tortilla chips was carried out. Three samples A, B, C were taken with 55% masa flour and 45% water, 60% masa flour & 40% water, 50% masa flour & 50% respectively. Sample C was selected based on sensory evaluation.

2.3 Optimization of Temperature

Ingredients	Samples		
	A	B	**C**
Water (%)	50	50	**50**
Masa Flour (%)	50	50	**50**
Temperature (°C)	140	150	**160**

Table- 2. Optimization of temperature

This demonstrates the effect of temperature on the sample's properties. Increasing temperature from sample A to sample C shows optimization, suggesting that higher temperatures likely lead to improved characteristics. By maintaining constant ingredient ratios, the table shows the impact of temperature, providing insights into the ideal temperature for optimizing the properties of the mixture.

2.4 Optimization of cooking time

Ingredients	Samples		
	A	**B**	C
Water (%)	50	**50**	50
Masa flour (%)	50	**50**	50
Temperature (°C)	160	**160**	160
Time (min)	10	**11**	12

Table -3. Optimization of cooking time

This demonstrates the cooking time (10, 11, 12 min) for tortilla snack (50% water, 50% masa flour) at same temperature (160°C). This aims to find the shortest perfect cooking time

2.5 Optimization of finger millet flour

Ingredients	Samples		
	A	B	**C**
Water (%)	50	50	**50**
Masa flour (%)	25	30	**35**
Finger millet flour (%)	25	20	**15**

Table -4. Optimization of finger millet flour

For Optimization of Finger millet flour ,3 samples were taken i.e. A, B, C. For Sample A, B and C, water, masa flour and finger millet flour were in the proportions (50,25,25), (50,30,20), (50,35,15) respectively. Based on sensory evaluation Sample C was selected.

2.6 Optimization of sorghum flour

Ingredients	Samples		
	A	B	**C**
Water (%)	50	50	**50**
Masa flour (%)	25	30	**35**
Finger millet flour (%)	5	7.5	**10**
Sorghum flour (%)	10	7.5	**5**

Table -5. Optimization of sorghum flour

Further percentage of sorghum flour was optimised. For sample A, B, C percentage of water and masa flour were kept constant i.e. 50% water and 35% masa flour. Whereas percentage of finger millet flour and sorghum flour vary. Ragi and sorghum for A, B, C were 5% and 10%, 7.5% and 7.5%, and 10% and 5% respectively. Based on the evaluation Sample C was selected.

3. RESULT AND DISCUSSION:

3.1 FORMULATION OF FINAL PRODUCT

Ingredients	Quantity (g))
Masa Flour	35
Water	50
Finger Millet Flour	10
Sorghum Flour	5
Seasoning	10

Table- 7. Formulation of Final Product

The table outlines the formulation of a final product. Masa flour forms the bulk of the recipe, with 35 grams being utilized. Water, at 50 ml, serves as a hydration agent to bind the ingredients together and achieve the desired consistency. Finger millet flour and sorghum flour are incorporated in smaller quantities, adding unique flavors and nutritional benefits to the product. Seasoning, constituting 10 g of the final product, provides flavour enhancement and customization options, allowing for adjustments to suit taste preferences.

3.2 Physico-chemical Analysis of Raw Material

The chemical analysis was done to analyse the quality of raw material required for multi millet tortilla snack.

Parameters(%)	**Masa Flour**	**Finger Millet Flour**	**Sorghum Flour**
Moisture	10.8	8.76	7.52
Fat	3.5	1.08	3.3
Protein	10	7	10
Ash	0.4	0.98	1.29

Table -8. Physico-chemical Analysis of Raw Material

Moisture content of Masa Flour, Finger Millet Flour and Sorghum Flour are 10.8%, 8.76% and 7.52% respectively, this indicates the amount of water present in the raw materials. Higher moisture content can affect the shelf life and texture of the final product. Lower moisture content in sorghum flour suggests better stability. Fat content of Masa Flour, Finger Millet Flour and Sorghum Flour are 3.5%, 1.08% and 3.3% respectively, this influences

the flavour, texture, and nutritional profile of the tortilla snacks. Higher fat content in masa and sorghum flour may contribute to a richer taste, while finger millet flour has lower fat content. Protein content of Masa Flour, Finger Millet Flour and Sorghum Flour are 10%, 7% and 10% respectively, this is crucial for the structure and nutritional value of the snacks. Sorghum and masa flour have similar protein content, while finger millet flour has slightly less. This may affect the overall protein content of the final product. Ash content of Masa Flour, Finger Millet Flour and Sorghum Flour are 0.4%, 0.98% and 1.29% respectively, this represents the mineral content of the raw materials. Higher ash content may indicate a higher concentration of minerals and other inorganic compounds. Sorghum flour has the highest ash content, suggesting potentially higher mineral content compared to the other flours.

3.3 Sensory analysis of control sample:

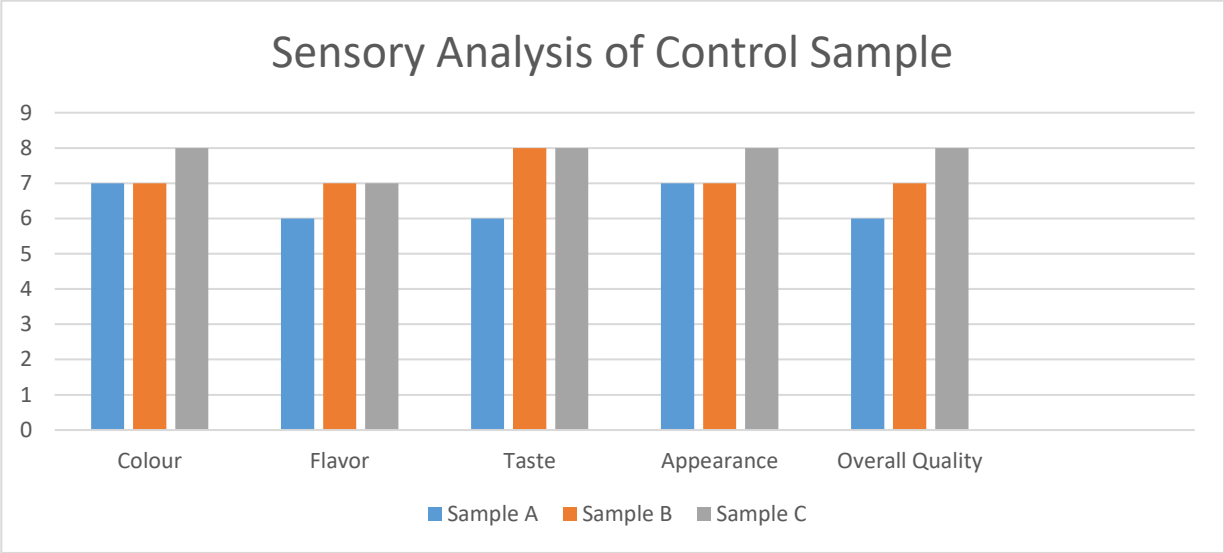

Fig -3: Sensory Analysis of Control Sample

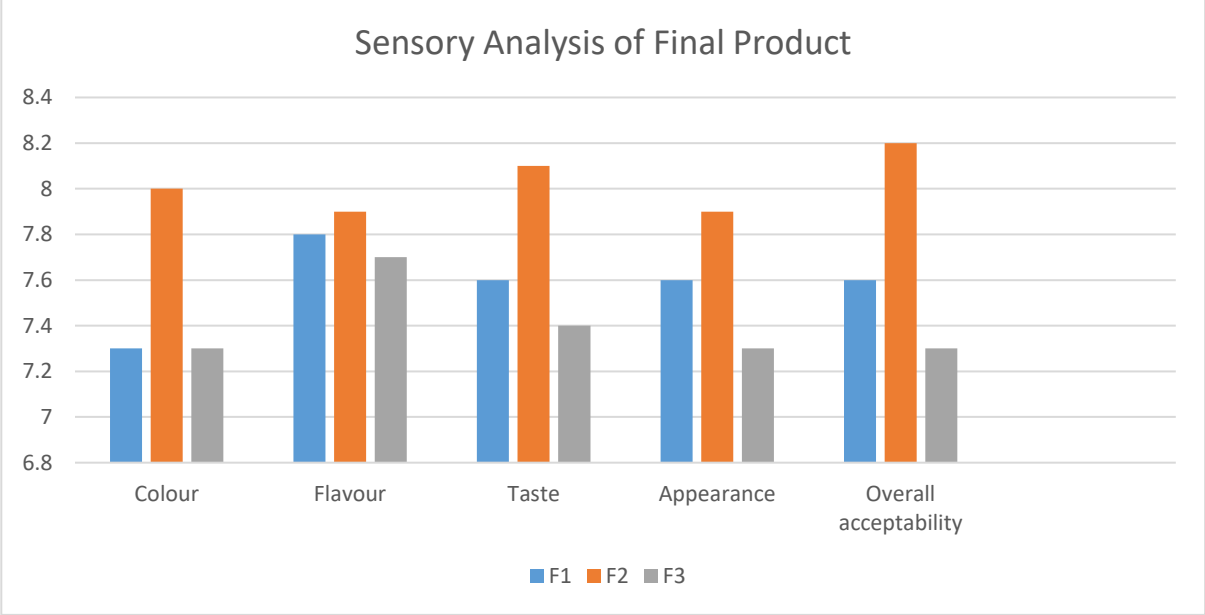

Fig -4: Sensory Analysis of Final Product

3.4 Physical Analysis of multi millet tortilla snacks:

3.4.1. Thickness of multi millet tortilla snacks:

Sample	**Thickness (mm)**
T1	2
T2	3
T3	2

Table -9 Thickness of multi millet tortilla snack

The thickness of the tortilla snacks varies for different samples, ranging from 2 mm to 3 mm. Sample T1 and Sample T 3 both have a thickness of 2 mm, while Sample T2 has a thickness of 3 mm. This data indicates some variability in the thickness of the tortilla snacks across different samples, which could impact their texture and mouthfeel

3.4.2 Texture Analysis of multi millet tortilla snacks:

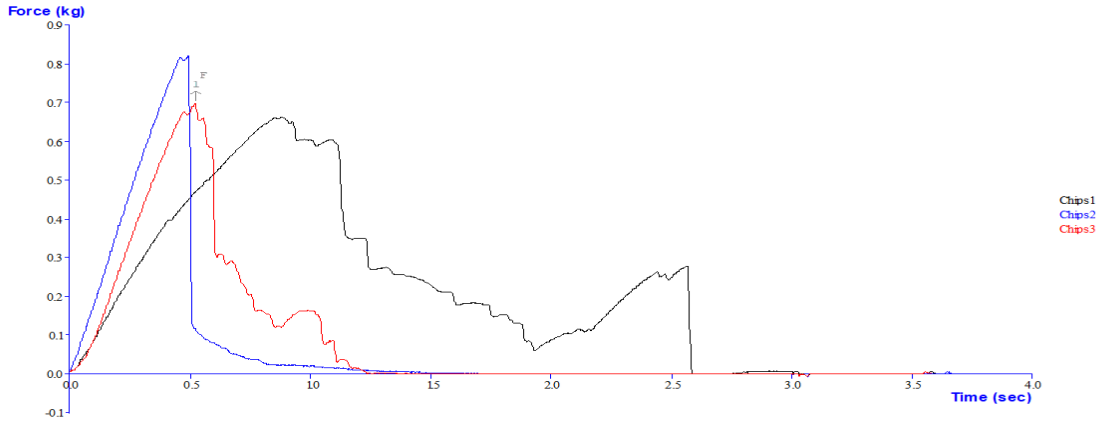

Fig- 5. Fracturability of Tortilla Snack

Triplicate of Same sample ($\sigma < 0.05$)

Test ID	Batch		Fracturability
			G
			Force 1
Start Batch Chips	Chips		
Chips1	Chips		665.122
Chips2	Chips		822.803
Chips3	Chips		700.937
End Batch Chips	Chips		
Average	Chips (F)	AVERAGE("BATCH")	729.621
S.D.	Chips (F)	STDEVP("BATCH")	67.493
C.V.	Chips (F)	STDEVP("BATCH")/AVERAGE("BATCH")*100	9.25
End of Test Data			

Table -10. Fracturability of Tortilla snack

The test ID serves to uniquely identify the specific test being conducted within a batch of chips. A batch, on the other hand, refers to the group of chips undergoing testing. Fracturability, a key metric, gauges the force required to break the chips. Within the batch, the start and end markers delineate the beginning and conclusion of the testing process. Individual chips within the batch are denoted as Chips 1, Chips 2, and Chips 3, each undergoing testing to yield individual results. The average fracturability force (F) and its standard deviation (S.D.) are calculated across the chips, providing insights into the overall performance and variability within the batch. The coefficient of variation (C.V.) for fracturability force, expressed as a percentage, further elucidates the consistency or variability in chip strength. To ensure accuracy, the test is conducted in triplicate, repeated three times to ensure consistency and reliability of results.

3.4.3. Colour Analysis of multi millet tortilla snacks:

Hunter Lab Colorimeter is used to obtain values.

Sample	L*	a*	b*
T1	61.92	8.03	25.90
T2	52.55	11.36	30.83
T3	55.57	10.26	30.51

Table -11 Colour analysis of Multi millet tortilla snack

Hunter Lab Colorimeter measures color with L*, a*, and b* values.

Where: L*: Lightness (0-100), higher values are lighter.

a*: Red-green axis, positive for red, negative for green.

b*: Yellow-blue axis, positive for yellow, negative for blue.

For the samples:

Sample 1: Light (L*=61.92) with moderate red and yellow tones.

Sample 2: Slightly darker (L*=52.55) with higher red and yellow tones.

Sample 3: Intermediate (L*=55.57) with similar tones to Sample 2.

3.4.4 Chemical Analysis of multi millet tortilla snacks:

Parameters(%)	**Multi millet tortilla snack**
Moisture	4.6
Carbohydrate	70.96
Fat	11.29
Protein	11.82
Ash	1.33

Table - 12. Physico-chemical analysis of multi millet tortilla snack

The percentage of moisture, fat, protein, and ash are 4.6, 2.4, 1.7 and 4 respectively. Low moisture extends shelf life, moderate fat for taste and texture, low protein but still nutritious and high ash indicates mineral richness.

3.4.5 Microbial Analysis

3.4.5.1. Yeast and Mould count

Microbial Parameters	SAMPLE	Colony Count					
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Yeast and Mould (cfu/g)	T1	ND	ND	ND	ND	ND	6×10^{-4}

Table -13. Changes in microbial load of tortilla snack

The table displays microbial parameters, specifically yeast and mold colony counts, across six weeks of two trials. "ND" indicates "Not Detected," implying that yeast and mold were absent in the samples during the first five weeks of both trials. In Trial 1, during the sixth week, yeast and mold were detected at a colony count of 6×10^-4 cfu/g indicating potentially differing microbial growth or environmental conditions between the trials. Hence, number of colonies found are 50,000 cfu/g.

3.4.5.2 Total Plate count

Microbial Parameters	Sample	Colony Count					
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Total Plate count	T1	ND	ND	ND	ND	ND	ND

Table - 14. Total Plate count

The table represents microbial parameters, specifically the total plate count, over a span of six weeks. Throughout the duration of the study, from Week 1 to Week 6, the total plate count consistently shows "ND" (Not Detected), indicating the absence of microbial growth in the samples during each week. This suggests that the samples remained free from microbial contamination or that any microbial growth present was below the detection limit of the analysis method employed.

Conclusion:

Multi-millet tortilla snacks are highly acceptable among gluten intolerant people due to its gluten-free property and people seeking for oil free alternatives of snacks. Firstly, the emphasis on multi-millet composition underscores a strategic approach towards enhancing nutritional profiles. Furthermore, the gluten-free nature of multi-millet tortilla snacks caters to a demographic often underserved in the snack market individuals with gluten intolerance. For this segment of the population, access to delicious and safe snack options can be limited. In conclusion, the development and evaluation of multi-millet tortilla snacks heralds a new era of snack innovation, characterized by a fusion of nutritional excellence and dietary inclusivity. These snacks not only excel in their nutritional properties but also cater to a specific dietary needs and preferences, making them a versatile and appealing choice for consumers seeking wholesome, gluten-free, and oil-free snack options.

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