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Development of Functional Tortilla chips by Incorporation of Arjuna (*Terminalia arjuna*)

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ABSTRACT
Tortilla chips are the expanding market within the salty snacks category of India. Terminalia arjuna L. is a major ingredient in many Ayurvedic preparations. In this investigation, attempts have been made to develop functional tortilla chips from corn, ragi, quinoa, Terminalia arjuna *and turmeric etc. The preparation process was consisted of two steps viz. masa flour preparation and tortilla chips preparation. Tortilla chips were deep-fat fried by using sunflower oil at 190° C for 1-2 min in a fryer. All grains were nixtamilized for the preparation of flour to be used for the preparation of tortilla chip. Grain flours were produced by grinding in Pulverizer. On the basis of sensory analysis the composite flour was formulated containing corn, ragi, and quinoa in 60:20:20 respectively, to supplement tortilla chips. This formulation was further substituted with* Terminalia arjuna *powder from 0-2%. The incorporation of* Terminalia arjuna *led to the addition of medicinal value and improved the functional quality of tortilla chips. As a result, the study was found to be successful at developing functional tortilla chips with a good nutritional profile. Functional Tortilla chips would have an enormous impact on the future market.*
Keywords: *Functional Food, Tortilla Chips, Ragi, Quinoa and Terminalia arjuna*

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INTRODUCTION

In India, Fried chips are the most common and popular snack food. Tortilla chips are corn snack products, which are produced by nixtamalization process. Nixtamalization process involves alkaline cooking, steeping, washing and stone grinding of the kernels to produce corn masa. This process helps to soften the pericarp, endosperm and to gelatinize the starch (6). After kneading and molding the triangular shape tortilla mass is fried in vegetable oil. These snack chips provide instant energy, as they are good source of nutrients (11, 12, and 15).

The growth of interest in the relationship between health, diet and food products has led to the development of functional foods. Functional foods can improve health in a convenient way (10). FOSHU organization of Japan states that *functional foods are processed foods containing ingredients that aid specific body functions in addition to being nutritious.* The American Dietetic Association (ADA) states that *functional foods comprise whole foods, fortified, enhanced or enriched foods, have a potentially beneficial effect on health when consumed as part of a varied diet and on a regular basis, at effective levels* (11, 17, and 23).

The plant *Terminalia arjuna* L. is an excellent source of natural antioxidants due to which it has been extensively investigated for its uses in both Ayurvedic and Yunani systems of medicine. The bark of *Terminalia arjuna* contains large amount of triterpenoids. Triterpenoids isolated from its bark are 459 ainlyarjunin, arjunetin, arjunic acid, arjugenin. *Terminalia arjuna* based phytochemicals are considered as one of the best tonic for healthy cardiovascular system. It is a vital ingredient in many Ayurvedic preparations aimed at improving cardiovascular health (2, 4, 9, 18, 20, and 22).

Curcuma longa L. (turmeric) is highly regarded as an herbal medicine. It contains curcumin, which has yellow color. It exerts several protective effects on the gastrointestinal tract of human (3, 16). Quinoa contains essential amino acids including methionine and lysine that are commonly limited in cereals. It has good protein digestibility. It provides a protein value similar to casein in milk with high content of calcium, phosphorus, iron, B complex vitamins and fiber (1, 24).

The key motive for using *Terminalia arjuna* L in the present investigation for development of tortilla chips was to improve the functional properties of the snacks.

MATERIAL AND METHODS

Terminalia arjuna L. powder was procured from an herbal medicine store present in Kolhapur, Maharashtra. The other ingredients such as corn, ragi, quinoa, sunflower oil, shortening, chili powder,

turmeric and salt were procured from local grocery stores of Uchgaon, Kolhapur. The food grade lime was procured from a reliable chemical supplier of Kolhapur, Maharashtra.

The chemical composition (nutritional properties) of the raw materials and functional tortilla chips were accessed in the laboratory of Department of Technology, Shivaji University, Kolhapur, Maharashtra, India. Moisture, Protein, Crude Fiber, Carbohydrate, Fat and Ash were determined according to the official method of A.O.A.C., 2005(7).

PREPARATION OF TORTILLA CHIPS

Functional tortilla chips were prepared with slight modifications by the methods provided by Chhabra, N., Kaur, A., and Kaur, S. (2017) and Quintero-Fuentes *et al.* (1999). The preparation process was consisted of two steps viz. masa flour preparation and tortilla chips preparation (5,19).

Masa flour preparation

100 g of ragi and quinoa were cooked with 250 ml of water and 0.5 g lime for 30 minutes, while corn was cooked with 300 ml water and 1.5 g lime for 1 hour. After that, cooked grains were steeped at room temperature 25±2°C for 24 hours followed by washing and coarsely grinding. The grinded sample was oven dried at 50°C. At last, grain flours were produced by grinding in Pulverizer.

Tortilla chip preparation

Masa flour (72 g), of each formulation (Table 1) was mixed with shortening (8 g), salt (2 g), chili powder (1 g) and turmeric (0.5 g) etc. This was hydrated with optimum amount of mineral water and kneaded uniformly to produce soft dough masa. Then Masa was allowed to rest in a cotton cloth for 10-15 min. Dough balls of 25 g masa were pressed and shaped into 1 mm thick flat discs using a manual tortilla press. The discs of dough were baked to 240° C for 2 minutes. The baked chips were given a period of 10-15 minutes for packaging so that all the moisture in it gets the balance. The sheet masa discs were placed on plastic trays and cut manually with a round pizza cutter in both transverse directions. Tortilla chips were then deep-fat fried by using sunflower oil at 190°C for 1-2 min in a fryer. The fried chips were then cooled and packed (5, 19).

Sensory analysis

Sensory evaluation of functional tortilla chips was carried out by using a panel of minimum 10 semi trained judges on 9 point hedonic scale for appearance, color, aroma, texture and overall acceptability. On the basis of sensory analysis, most acceptable formulation was selected for further study (5, 13).

Table 1: Tortilla chips formulation using corn, ragi and quinoa masa flour

Formulation	Corn (g)	Ragi (g)	Quinoa (g)
1	100	0	0
2	90	10	0
3	90	0	10
4	80	20	0
5	80	10	10
6	80	0	20
7	70	30	0
8	70	20	10
9	70	10	20
10	70	0	30
11	60	40	0
12	60	30	10
13	60	20	20
14	60	10	30
15	60	0	40
16	50	50	0
17	50	40	10
18	50	30	20
19	50	20	30
20	50	10	40
21	50	0	50

Image 1: Tortilla Disc

Image 2: Functional Tortilla Chips (Final Product)

Incorporation of *Terminalia arjuna* in composite flour

In the selected formulation, *Terminalia arjuna* powder was incorporated at level of 0.5, 1, 1.5 and 2%. Tortilla chips prepared with the replacement of composite flour with *Terminalia arjuna* (0.5, 1, 1.5 and 2%). Then enriched functional tortilla chips were evaluated for sensory parameters.

RESULTS AND DISCUSSION

Chemical Composition:

The moisture content of corn, ragi, and quinoa were found to be 8±0.04 g, 13.1±0.1 g, and 13±0.2 g per 100 gram respectively. Among the raw materials quinoa had highest value of protein, fat, and crude fiber. This was within the range as evaluated by Mohyuddin *et al*., 2019(14). Corn and ragi were good source of carbohydrates. Ragi and Quinoa were found to be the excellent source of crude fiber. *Terminalia arjuna* powder supplementation in functional tortilla chips would be a major contributor in improving nutritional value in terms of natural antioxidants. The nutritional profile of the ragi was within the range as reported by Gull *et al*., 2014(8). The nutritional profile of the corn was within the range as reported by Ullah, I., Ali, M., and Farooqi, A., 2010 (21).

Table 2: Chemical composition of raw materials

Parameters	Corn	Ragi	Quinoa	Functional Tortilla Chips
Moisture (%)	8±0.04	13.1±0.1	13±0.2	1.6±0.02
Protein (%)	9.6±0.1	7.6±0.1	14±0.00	7±0.1
Fat (%)	4.3±0.08	1.5±0.06	6±0.1	23.6±0.02
Crude Fiber (%)	1.2±0.1	3.6±0.00	7±0.1	14.33±0.25
Carbohydrate (%)	76.9±0.07	75.2±0.16	64.6±0.23	66±0.36
Ash (%)	1.2±0.05	2.5±0.2	2.4±0.1	1.9±0.02
Energy (Kcal)	384.7±0.24	344.7±0.54	368.4±0.7	504±0.92

(All the given values are Mean± SD of 3 determinations.)

Sensory assessment of tortilla chips prepared from composite flours

Tortilla chips are generally formed of 100% nixtamilized corn flour. But in this study, these were prepared from different formulations that consist of corn, ragi and quinoa. Corn masa was subsequently replaced with ragi from 0-40% followed by best combination with quinoa masa 0-40%. The masa of respective grains were prepared as illustrated earlier. The preparation technology revealed by replacing the corn masa with ragi masa, tortilla chips became less sheetable, showed dark color and were very fragile however, their taste was acceptable. Further, quinoa was incorporated which gave fair structure and texture. Therefore, on basis of sensory acceptability, one best blend of tortilla chip (corn: ragi: quinoa; 60:20:20) was selected.

Table 3: Sensory scores of tortilla chips prepared from composite flours

Formulation	Color	Flavor	Taste	Texture	Overall Acceptability
1	7.5±0.85	7.28±1.17	7.65±1.06	7.6±0.7	7.51±0.51
2	7.3±0.67	7.08±1.00	7.15±0.88	7.3±0.67	7.21±0.58
3	7.1±0.74	6.98±1.06	7.25±0.92	7.3±0.82	7.16±0.62
4	7.5±0.97	7.08±0.74	7.25±0.92	7.5±0.71	7.33±0.57
5	7.6±0.84	7.28±0.96	7.45±0.83	7.7±0.48	7.51±0.38
6	7.9±0.88	7.38±0.98	7.55±0.83	7.8±0.42	7.66±0.32
7	8±0.82	7.58±0.86	7.75±0.79	7.9±0.57	7.81±0.33
8	8.2±0.79	7.78±0.66	7.95±0.83	8.2±0.42	8.03±0.36
9	8.3±0.67	7.88±0.61	8.15±0.47	8.4±0.52	8.18±0.23
10	8.4±0.52	7.98±0.70	8.15±0.47	8.4±0.52	8.23±0.21
11	8.3±0.67	8.08±0.61	8.25±0.54	8.3±0.48	8.28±0.29
12	8.3±0.48	7.9±0.57	8.3±0.48	8.3±0.48	8.23±0.18
13	8.4±0.52	8.3±0.48	8.4±0.52	8.4±0.52	8.38±0.18
14	8.3±0.48	8.08±0.61	8.35±0.58	8.3±0.48	8.26±0.22
15	8.2±0.63	7.9±0.88	8.2±0.63	8.1±0.57	8.1±0.36
16	7.8±0.92	7.9±0.74	7.8±0.42	7.7±0.95	7.8±0.50
17	7.9±0.88	8±0.82	7.8±0.63	7.8±0.92	7.88±0.48
18	7.8±0.92	8±0.94	7.7±0.48	8.1±0.88	7.9±0.43
19	8±0.67	7.9±0.88	7.7±0.82	8.1±0.74	7.93±0.44
20	8.1±0.57	8.1±0.57	7.8±0.42	8±0.47	8±0.24
21	8.2±0.42	7.9±0.57	7.7±0.67	7.9±0.88	7.93±0.35

Effect of incorporation of *Terminalia arjuna* on quality and sensory attributes of tortilla chips

As the concentration of *Terminalia arjuna* increased, the taste of chips becomes astringent. Functional chips containing 0.5% *Terminalia arjuna was less pungent than the 2%*. The functional chips with 1% of *Terminalia arjuna secured more score for color, flavor, taste and texture.*

Table 4: Effect of *Terminalia arjuna* on sensory attributes of tortilla chips

Level %	Color	Flavor	Taste	Texture	Overall Acceptability
Control	8.4±0.52	8.3±0.48	8.4±0.52	8.4±0.52	8.38±0.18
1	8.4±0.52	8.2±0.48	8.3±0.48	8.3±0.48	8.38±0.18
2	8.4±0.52	8.4±0.52	8.4±0.52	8.4±0.52	8.4±0.21
3	8.3±0.48	8.1±0.32	8.1±0.32	8.3±0.48	8.2±0.23
4	8.2±0.42	8±0.47	7.8±0.42	8.3±0.67	8.08±0.17

CONCLUSION

In this investigation, attempts have been made to develop functional tortilla chips from corn, ragi, quinoa, *Terminalia arjuna* and turmeric etc. All grains were nixtamilized for the preparation of flour to be used for the preparation of tortilla chip. Grain flours were produced by grinding in Pulverizer. On the basis of sensory analysis the incorporation of *Terminalia arjuna* led to the addition of medicinal value and improved the functional quality of tortilla chips. As a result, the study was found to be successful at developing functional tortilla chips with a good nutritional profile. Functional Tortilla chips would have an enormous impact on the future market of India.

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