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FORMULATION AND EVALUATION OF FINGER MILLET BASED EXTRUDED PRODUCT (FINGER MILLET SHELLS)

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ABSTRACT

The aim of the study was to develop an extruded product, using finger millet and nuts (cashew and almonds). Finger millet is a rich source of Calcium, Iron, Protein, Fiber and other minerals. The cereal has low fat content and contains mainly unsaturated fat. Cashews are high in calories. 100g of nuts provide 553 calories. They are packed with soluble dietary fiber, vitamins, minerals and numerous health-promoting phyto- chemicals that help protect from diseases and cancers. Almond nuts are rich sources of vitamins, and minerals and packed with numerous health promoting phyto-chemicals. The extruded product was developed using refined wheat flour and semolina, along with finger millet and nuts, with variations in the finger millet and cashew – almonds powder compositions. The quality parameters have been assessed. Proximate analyses such as moisture content, ash, and acid insoluble ash were conducted. Sensory evaluation and proteins, fats, and carbohydrates were determined according to the standard methods available. The storage stability was good in final product with respect to texture and flavor.

KEYWORDS: Product, Phyto-Chemicals, Proteins, Fats

INTRODUCTION

Extrusion is a process which combines several unit operations including mixing, cooking, kneading, shearing, shaping and forming. Extrusion technologies have an important role in the food industry as efficient manufacturing processes. Their main role was developed for conveying and shaping fluid forms of processed raw materials, such as dough's and pastes.

Extrusion cooking technologies are used for cereal and protein processing in the food and, closely related, pet foods and feeds sectors. The processing units have evolved from simple conveying devices to become very sophisticated in the last decade. Today, their processing functions may include conveying, mixing, shearing, separation, heating or cooling, shaping, co-extrusion, venting volatiles and moisture, flavor generation, encapsulation and sterilization. They can be used for processing at relatively low temperatures, as with pasta and half product pellet dough's, or at very high ones with flatbreads and extruded snacks. The pressures used in extruders to control shaping, to keep water in a superheated liquid state and to increase shearing forces in certain screw types, may vary from around 15 to over 200 atmospheres.

Extrusion cooking has gained in popularity over the last two decades for a number of reasons

- Versatility: a wide range of products, many of which cannot be produced easily by any other process, is possible by changing the ingredients, extruder operating conditions and dies
- Cost: extrusion has lower processing costs and higher productivity than other cooking and forming processes
- Productivity: extruders can operate continuously with high throughput
- Product quality: extrusion cooking involves high temperatures applied for a short time, retaining many heat sensitive components of a food
- Environmentally-friendly: as a low-moisture process, extrusion cooking does not produce significant process effluents, reducing water treatment costs and levels of environmental pollution.

Keeping in view these facts an attempt has been made to develop millet nut based extruded product. In this study, finger millet (i.e., ragi) flour , cashew and almonds in powdered form are incorporated into the formulation along with regularly used basic ingredients in an extrusion cooking process i.e., refined wheat flour and semolina.

Finger Millets

Finger Millet, also known as Ragi, is cultivated in drier parts of the world, mainly in Asia and Africa. Ragi has a distinct taste and is widely used in Southern Indian and Ethiopian dishes. Ragi is a rich source of Calcium, Iron, Protein, Fiber and other minerals. The cereal has low fat content and contains mainly unsaturated fat. It is easy to digest and does not contain gluten; people who are sensitive to gluten can easily consume Finger Millet. Ragi is considered one of the most nutritious cereals. It has different names in local languages.

Nutrition Facts and Health Benefits

For losing weight: Ragi contains an amino acid called Tryptophan, which lowers appetite and helps in keeping weight in control.

For bone health: Ragi is rich in Calcium, which helps in strengthening bones. It is an excellent source of natural calcium, for growing children and aging people.

For diabetes: Finger Millets photochemical help in slowing digestion process. This helps in controlling blood sugar level in condition of diabetes.

For lowering Blood cholesterol: Finger Millet contains amino acids Lecithin and Methionine, which help in bringing down cholesterol level, by eliminating excess fat from Liver.

For anaemia: Ragi is a very good source of natural Iron. Ragi consumption is recommended in cases of Anaemia.

For relaxation: Ragi consumption helps in relaxing body, naturally. It is beneficial in conditions of anxiety,

depression and insomnia. Ragi is also useful for migraines.

For protein/amino acids: Ragi is rich in Amino Acids, which are vital in normal functioning of body and are essential for repairing body tissues. Finger Millet contains Tryptophan, Threonine, Valine, Isoleucine and Methionoine aminoacids. Isoleucine helps in muscle repair, blood formation, contributes to bone formation and improves skin health.

For other health conditions: If consumed regularly, Ragi could help in keeping malnutrition, degenerative diseases and premature aging at bay.

Ragi is an extremely nutritious cereal and is very beneficial for maintaining a good health.

Cashew Nuts

Delicately sweet yet crunchy and delicious cashew nut is packed with energy, antioxidants, minerals and vitamins that are essential for robust health. Cashew, or “kaju” in Portuguese, is one of the popular ingredients in sweet, as well as savory dishes worldwide.

Botanically, cashew is an average sized tropical evergreen tree belonging to the Anacardiaceous family, in the genus: Anacardium. Scientific name: **Anacardium occidentale.**

Nutrition Facts and Health Benefits

Cashews are high in calories. 100g of nuts provide 553 calories. They are packed with soluble dietary fiber, vitamins, minerals and numerous health-promoting phyto-chemicals, which help protect from diseases and cancers.

They are rich in “heart-friendly” monounsaturated-fatty acids like oleic, and palmitoleic acids. These essential fatty acids help lower harmful LDL-cholesterol while increasing good HDL cholesterol in the blood.

Cashew nuts are abundant sources of essential minerals. Minerals, especially manganese, potassium, copper, iron, magnesium, zinc, and selenium are concentrated in these nuts. A handful of cashew nuts a day in the diet would provide enough of these minerals and may help prevent deficiency diseases. Selenium is an important micronutrient, which functions as a co-factor for antioxidant enzymes such as Glutathione peroxidases, one of the most powerful antioxidants in the body. Copper is a cofactor for many vital enzymes, including cytochromec-oxidase and super oxide dismutase (other minerals function as co-factors for this enzyme are manganese and zinc). Zinc is a co-factor for many enzymes that regulate growth and development, gonadal function, digestion, and DNA (nucleic acid) synthesis.

Cashews are also good in many essential vitamins such as pantothenic acid (vitaminB5), pyridoxine (vitaminB-6), riboflavin, and thiamin (vitaminB-1). Pyridoxine reduces the risk of homocystinuria, and sideroblastic anemia. Niacin helps prevent "pellagra" or dermatitis. Additionally, these vitamins are essential for metabolism of protein, fat, and carbohydrates at the cellular level.

Further, the nuts are also hold a small amount of zea - xanthin, an important pigment flavonoids antioxidant, which selectively absorbed into the retinal macula lutea in the eyes. It is thought to provide antioxidant and protective UV ray filtering functions and helps prevent age-related macular degeneration (ARMD) in the elderly.

Almonds

Wonder fully delicious, almonds have long been revered as an epitome of wellness and health. The kernels are

among the richest sources of health-benefiting nutrients essential for optimum health.

Botanically, they are the fruits obtained from medium size tree belonging to the family of Rosaceae, in the genus: Prunus.

Scientific name: **Prunusdulcis**.

Nutrition Facts and Health Benefits

Almond nuts are rich sources of vitamins, and minerals and packed with numerous health promoting phyto-chemicals. These nuts compose of well-balanced food principles that are essential for optimum health and wellness.

Almonds are one of the complete sources of energy as well as nutrients. The nuts, especially, are rich in mono-unsaturated fatty acids like oleic, and palmitoleic acids that help in lowering LDL or "bad cholesterol" and increasing HDL or "good cholesterol" in the human body.

The nuts are an excellent source of **vitamin E**; hold about 25g per 100g (about 170% of RDA). Vitamin E is a powerful lipid soluble antioxidant, required for maintaining cell membrane integrity of mucus membranes and skin by protecting it from harmful effects of oxygen-free radicals.

The nuts are packed with many important B-complex groups of vitamins such as riboflavin, niacin, thiamin, pantothenic acid, vitamin B-6, and foliates. Altogether, these vitamins work as co-factors for enzymes during cellular substrate metabolism inside the human body.

Furthermore, almonds are also an incredible source of minerals such as manganese, potassium, calcium, iron, magnesium, zinc, and selenium.

MATERIALS AND METHODS

Different samples were prepared by varying the percentage composition of finger millet and cashew - almonds powder in that order: T_1 (15 - 10%) and T_2 (20 - 5%).

Formulation 1 (T_1)

- Refined wheat flour-500g (50%)
- Semolina -250g (25%)
- Finger millet powder -150g (15%)
- Cashew and almonds (powdered) -100g (10%)

Formulation 2 (T_2)

- Refined wheat flour - 500g (50%)
- Semolina - 250g (25%)
- Finger millet powder - 200g (20%)
- Cashew and almonds (powdered) - 50g (5%)

Food Extrusion is a process in which a food material is forced to flow under one or more of a variety of conditions of mixing, heating and shear through a die which is designed to form and puff dry the ingredients. When boiled in water for 10 min then should swell twice in volume.

They should retain shape and firmness without becoming pasty or dissipating when boiled in water. The minimum protein content should be 11.5%, moisture content should not exceed 12.5% and ash content should be in the range of 0.6-0.85%.

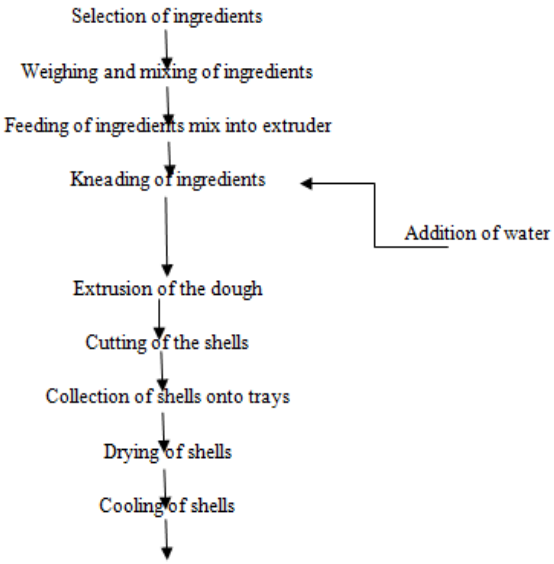

Figure 1: Flow Sheet for Manufacturing of Finger Millet Shells

The weighed amounts of samples are fed into the extrusion machine. Sufficient amount of water is added to it and allowed for kneading process.

About 330ml of water is added to the metered ingredients, which is sufficient to form the required dough.

The kneading process is done by keeping the equipment in kneading operation mode.

Water is added regularly intervals for uniform mixing of the flour ingredients.

The required die is set to the machine previously and after kneading is done properly and completely, the operating mode is changed to extrusion to obtain the extruded product.

There are different types of dies which produce different shapes of extruded products.

Here, a die which produce an extrudate in the shape of a shell is used.

The color of the extruded shell type product may be dark, as there is an incorporation of ragi flour.

Finally, the extruded product is carefully collected into a tray and is kept in a tray drier, to dry the product (at 60°C for 2 hrs).

The dried shells are then packed in pouches and studied for the shelf life.

ANALYSIS OF THE PRODUCT

The samples were subjected to proximate analysis i.e., moisture, protein, ash, fat and carbohydrates except fiber using AOAC (1995) methods. The analysis is carried out for 7 days of time interval up to one month and final analysis is done for 45 days.

Moisture Content

The sample is heated under conditions (105°C for 3 hrs) of reduced pressure to remove water and the loss of weight is used to calculate the moisture content of the sample.

Calculation of % moisture content:

$$\text{Moisture content (\%)} = \frac{\text{initial wt} - \text{final wt}}{\text{wt of sample}} * 100$$

Fat Content

Fat is extracted, semi continuously, with an organic solvent. Solvent is heated and volatilized, then is condensed above the sample. Solvent drips onto the sample and soaks it to extract the fat. At 15–20 min intervals, the solvent is siphoned to the heating flask, to start the process again. Fat content is measured by weight loss of sample or weight of fat removed.

Calculation of % fat:

$$\%\ (\text{Fat + moisture}) = \frac{(\text{initial wt + thimble + glasswool}) - (\text{final wt + thimble + glasswool}) * 100}{(\text{wt of wet sample + thimble}) - (\text{wt of thimble})}$$

Carbohydrates

Total CHO (g/100g dry weight) = 100- (g protein + g crude fiber + g ash + g fat)

Energy

Energy (k cal/100g) = 4 x (g protein + g carbohydrates) + 9 x (g fat)

Sensory Evaluation

The finger millet shells are cooked or boiled in milk along with sufficient amount of sugar and prepared like a sweet porridge.

The sensory evaluation of dried shells and the shells cooked with milk was carried out using a panel made up of 9 members.

Snack attributes such as appearance, color, texture, flavor, taste, after taste and overall acceptability were evaluated using a 9-point hedonic scale questionnaire, where 1=like extremely, 5 is neither like nor dislike, 9 is dislike extremely

Table 1: Sensory Evaluation for Formulation 1 (T_1)

No of panelists	8		8		8		8		9	
	7th day		14th day		21st day		28th day		45th day	
Sample	Dried	Cooked	Dried	Cooked	Dried	Cooked	Dried	Cooked	Dried	Cooked
Appearance	7.45	8.45	7	8	7	8	7	8	6.5	7.5
Color	7.54	8.79	7	9	7	8	7	8	6.5	7.8
Texture	8	8	7.89	8.5	7	8	7	8	6.5	8
Flavor	6.67	8.5	6	8	6	8	6	8	6	8
Taste	6.18	8.4	6	8.6	6	9	6	9	5	8
After taste	6.25	8.6	7	8.5	6	8	6	8	5.5	8
Overall acceptability	7.5	8.6	7	8.5	7	8	7	8	6	8

Table 2: Sensory Evaluation for Formulation 2 (T_2)

No of panelists	8		8		8		8		9	
	7th day		14th day		21st day		28th day		45th day	
Sample	Dried	Cooked	Dried	Cooked	Dried	Cooked	Dried	Cooked	Dried	Cooked
Appearance	7.5	8.2	7	9	7	7.5	7	8	6.5	7.5
Color	7.5	8.9	7	9	7	8	7	8	6.5	7.8
Texture	8.2	8	7.9	8.2	7	8.5	7	8	6.5	8
Flavor	6.5	8.4	6.5	8.0	6	8.2	6	8	6	8
Taste	6.2	8.4	6	8.5	6	9	6	9	5	8
After taste	6.4	8.2	7	8.5	6.5	8	6.2	8	5.5	8
Overall acceptability	7.8	8.8	7	8.5	7	8.5	7	8	6	8

RESULTS AND DISCUSSIONS

Proximate Analysis

Moisture Content

The moisture content is maintained during the storage period and is recorded as below.

Table 3: Moisture Content Analysis for 45 Days

Days	T_1	T_2
0	4.8	5.89
7	5.1	7.99
14	7.5	8.23
21	8.6	8.52
28	8.93	8.97
45	9.12	9.15

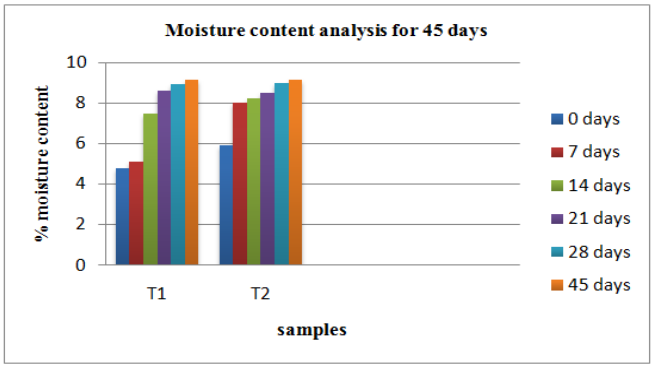

Figure 2: Bar Graph Representation of Moisture Content Analysis for 45 Days

Protein Content

Table 4: Protein Content Variation for 45 Days

Days	T_1	T_2
0	12.68	12.88
7	12.55	13.20
14	12.15	12.98
21	11.98	13.32
28	11.66	13.29
45	12.41	13.21

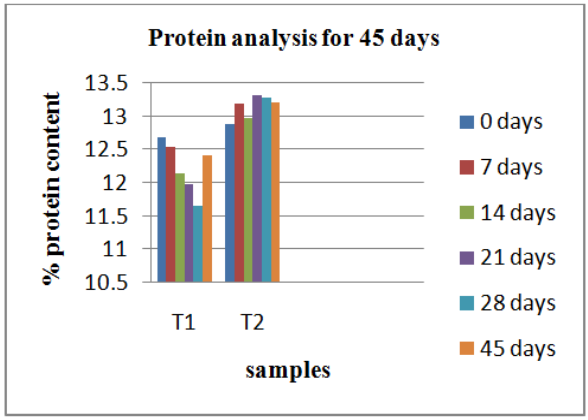

Figure 3: Representation of Protein Analysis for 45 Days

Fat Content

Table 4: Fat Content Changes In 45 Days

Days	T_1	T_2
0	5.76	4.18
7	5.49	3.58
14	5.40	4.00
21	5.38	3.79
28	5.36	3.38
45	5.14	3.16

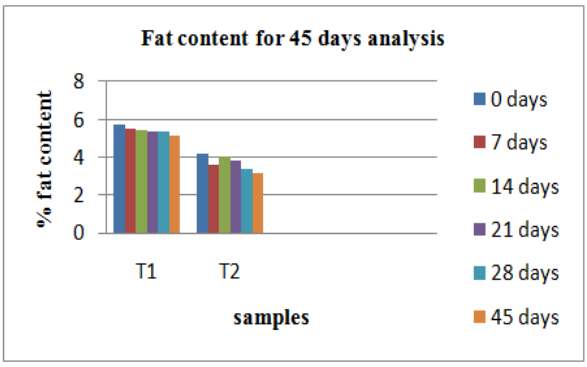

Figure 4: Representation of Fat Content for 45 Days Analysis

Ash Content

Table 5: Ash Content Results for 45 Days

Days	T_1	T_2
0	0.95	0.98
7	0.82	1.12
14	1.02	1.10
21	1.05	1.13
28	1.08	1.12
45	1.0	1.14

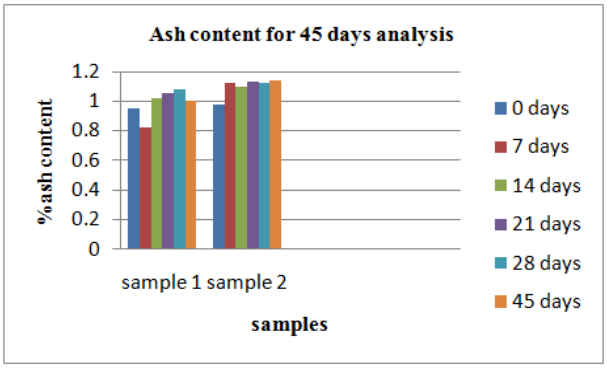

Figure 5: Representation of Ash Content for 45 Days Analysis

Carbohydrates

Table 6: Carbohydrates of Two Samples for 45 Days

Days	T_1	T_2
0	75.81	76.07
7	78.58	74.11
14	74.43	73.69
21	72.99	73.24
28	72.97	73.24
45	72.33	73.34

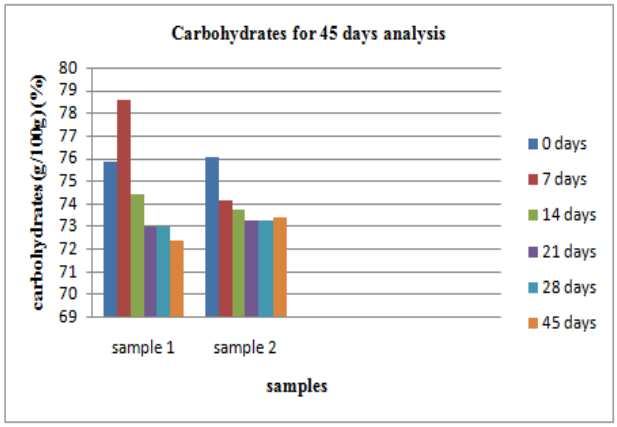

Figure 6: Bar Graph Representation of Carbohydrates

Energy

Table 7: Energy Recorded for 2 Samples for 45 Days

Days	T_1	T_2
0	405.8	393.42
7	392	381.46
14	391	382.68
21	388	380.35
28	387	376.54
45	385	374.64

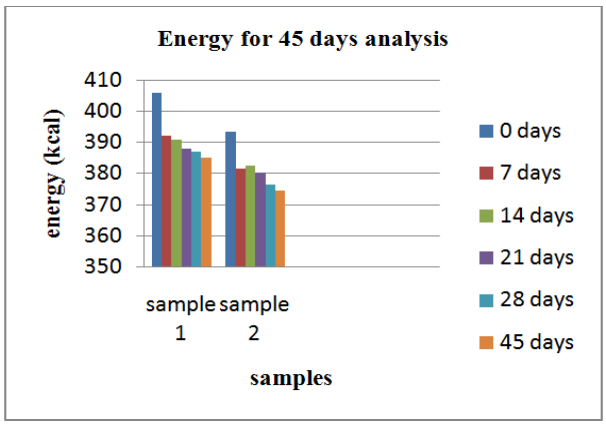

Figure 7: Graphical Representation for Energy Values for 45 Days Analysis

CONCLUSIONS

The present study revealed that incorporation of finger millet and cashew – almonds powder into the extruded product has given best results in terms of texture, color, and overall acceptability which were acceptable by the panelists, who have participated in the sensory evaluation. The proximate analysis of the finger millet shells from the day of preparation to 45th day was carried out and revealed that the moisture content has been increased. The final product was utilized by cooking/boiling in the milk, added with sufficient amount of sugar, was acceptable by the panelists primarily in

terms of flavor, taste, aftertaste, color and texture.

The addition of cashew – almonds powder produced a tingling sensation to the panelists, which was the main intention of its addition. Since the addition of finger millet flour produced a dark colored product, the dried finger millet shells gained a low acceptance in terms of color, but in case of shells cooked/boiled with milk and sugar, the panelists accepted the product at a high level in terms of color, flavor, texture and taste when compared to dried shells.

The finger millet shells (T_1) were superior to finger millet shells (T_2) in terms of color, flavor, texture and overall acceptance. In every case, the dried finger millet shells were accepted less compared to the finger millet shells cooked/boiled with milk.

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