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A STUDY ON THE DEVELOPMENT AND EVALUATION OF GLUTEN-FREE COOKIES

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ABSTRACT

Celiac disease, also known as gluten sensitive enteropathy, is a lifelong disorder in which gluten causes intestinal damage and nutrient loss. As a result, the goal of this study was to produce, standardise, and evaluate gluten-free cookies made with buckwheat flour and quinoa flour, both of which are gluten-free. Between buckwheat flour and quinoa flour, the following ratio of 3:4 (i.e., 75:100g) was utilised to make the cookies. After that, the cookies were evaluated for nutritional, physical, sensory, textural, storage, microbiological safety, and cost indices. The nutritional analysis of 45g of prepared cookies revealed 395.57 kcal of energy, 6.02g of protein, 8.21g of fat, 74.40g of carbohydrate, 1.28g of crude fibre, and 0g of gluten per 100g of cookies. The sensory evaluation was carried out using a composite score technique, with appearance, colour, texture, taste, and flavour being the factors examined. On day 1, the microbiological content of cookies was 600 CFU/g total plate count and 30 CFU/g yeast and mould, however on day 14, it was 9900 CFU/g total plate count and 130CFU/g yeast and mould. The evaluated cookies were commercialised to the public, and the cookies were well received.

KEYWORDS: Celiac disease, Gluten, Quinoa, Buck wheat.

INTRODUCTION

The gastrointestinal tract (GIT) is a complex and intricate machinery to process and absorb nutrients from food in an enormously managed and efficient way. One of the primary purpose of gastrointestinal tract (GIT) is to provide essential nutrients such as proteins, fats, and carbohydrates to the blood in a soluble form that can be further processed by the body [Aken, G. A. V 2010]. The functions of the gastrointestinal (GI) tract includes digestion, absorption, excretion, and protection which involves electrical activity and/or motor activity of the stomach and small intestine [Cheng, L. K et. al 2010]. The defects in intestinal barrier function are associated with diseases of the gastrointestinal (GI) tract. There is a growing proof that an increase in intestinal permeability plays a pathogenic role in diseases, such as Inflammatory Bowel Disease (IBD), celiac disease and functional bowel disorders, such as Irritable Bowel Syndrome (IBS) [Camilleri M et.al 2012]. Among all the functional Gastrointestinal (GI) disorders, celiac disease (CD) is one of the most common disease resulting from both environmental (gluten) and genetic factors (human leukocyte antigen HLA and non-human leukocyte antigen non-HLA). The occurrence of celiac disease has been predicted to approximately 0.5-1% in different parts of the world [Gujral, N et. al 2012].

Celiac disease (CD), also known as gluten-sensitive enteropathy and tropical sprue, is a prevalent autoimmune disorder that is triggered by the ingestion of wheat protein (gluten) and other related proteins of rye and barley in a genetically susceptible individuals [Briani, C et.al 2008]. Celiac disease (CD) leads to inflammation, villous atrophy, and crypt hyperplasia in the small intestine [Briani, C et.al 2008]. For the patients with celiac disease (CD), **the gluten-free diet (GFD)** is considered medical nutrition therapy that results in improvements in symptomatology and small bowel histology [Pietzak, M et.al 2012]. Therefore the absence of gluten in natural and processed foods represents a key component of food safety of the gluten-free diet. A promising area is the usage of minor or pseudo-cereals such as amaranth, buckwheat, quinoa, sorghum & teff and also milk & meat products, fats & oils, vegetables and fruits [Saturni, L et.al 2010].

Buckwheat *(Fagopyrum* genera of the *polygonaceae* family), is a pseudo-cereal growing in simple conditions and can prove as an imminent and forthcoming nutritional source for the “Starving World” [Chopra, N

et.al 2014]. Buckwheat was demonstrated to be abundant in various nutraceuticals, like unsaturated fatty acids, B vitamins, vitamin K, rutin, catechins, lysine and arginine, so buckwheat can complement well other vegetable and cereal proteins [Jie Ma, Y et.al 2013]. Buckwheat has higher lysine, iron, copper and magnesium content than wheat flour. These functional components of buckwheat have health benefits like reducing high blood pressure, lowering cholesterol, controlling blood sugar and preventing cancer risk. The incorporation of buckwheat flour in cookies can be justified as it has beneficial nutraceutical properties and its gluten free nature can play important role in preventing celiac problem [Chopra, N et.al 2014].

Quinoa (*Chenopodium quinoa*) originates from the highlands of South America [Lorenz, K et.al 1991]. Quinoa requires processing before use to remove anti-nutrient substances, mainly saponins. Compared with common cereals, quinoa contains more protein, lysine, fat and fibre [Coulter, L et.al 1990]. And also good source of dietary fibre, essential amino acids, linolenic acid and minerals, with good sensory acceptability and also no gluten in it [Brito, I. L et.al 2015].

As gluten-free products available in the market are recognized to have low nutritional quality and are more expensive than gluten-containing food products, so there is a strong need to develop gluten-free products that are nutritionally complete with sensory quality characteristics, compliance with the regulatory guidelines as well as economical [Jnawali, P et.al 2016].

MATERIALS AND METHODS

Procurement of raw materials

The raw material quinoa flour and buckwheat flour were purchased from the organic store. The other ingredients such as butter, egg, vanilla essence and sugar were purchased from the local supermarket.

Preparation of gluten-free cookies

Butter, sugar and vanilla essence were added together in a bowl and mixed well. Buckwheat and quinoa flour blends in 3:4 ratio were added to the above mixture and kneaded for 10 minutes. Finally egg was added and mixed with dough to get desired consistency. Then the dough was scooped into mounds of uniform thickness and arranged in a tray. And the scooped dough was placed inside the oven pre-heated at 150^{o}C for about 7-8 minutes and baked evenly.

Plate 1

Physical property

Weight of the cookies was measured with help of **'weighing scale'**. Thickness and diameter of cookies was determined by measuring cookies edge to edge using **'Vernier calliper'**. Spread ratio was calculated by dividing diameter of cookies by thickness of cookies.

Nutrient analysis

Proximate composition such as energy, total carbohydrate, protein, fat and gluten of gluten-free cookies was estimated. Estimation of energy and carbohydrate was done. Estimation of protein was done using 'kjeldal method' and fat was done by 'Soxhlet method' using 'Soxhlet extractor'. Presence of moisture content in cookies was estimated using **'**Hot Air Oven'.

The gluten content in cookies was calculated using a portable food sensor called the Nima Tester, which allows people with food allergies and sensitivities to analyse their food for specific proteins. A single-use capsule containing a food sample is inserted into the Nima sensor. The food is mixed with proprietary antibodies and assessed by the sensor in under 5 minutes once the test begins. Nima provides a binary result for the gluten and peanut test samples. The gluten sensor is set to detect gluten at 20 parts per million. Nima is meant to deliver a gluten detection if the sample contains 20 ppm or more of gluten.

Sensory evaluation

The 14 panellists were presented with prepared sample cookies for assessing and scoring each sensory attributes such as colour, appearance, texture, taste and flavour arranged in logical order on a score sheet. Using 20 point composite scoring test, the panellists made judgement on each attributes and the results were recorded on the sensory scoring card.

Microbial analysis

Microbial content of the cookies was estimated on day 1 and again on day 14 using **microscope.**

Shelf-life analysis

The shelf life of gluten-free cookies were analysed by storing the cookies in an **air-tight steel container** for 7 days and the sensory characteristics such as appearance, texture, colour, odour and taste were observed and recorded daily.

Cost analysis

The cost of one cookie was calculated on the basis of cost price of each ingredients used in making cookies.

Commercialization

The gluten-free cookies prepared and evaluated were commercialised in a residential apartment. Along with that, a feedback form was given to know what the consumers' like and dislike about the product, which will be helpful for further improvement of the product. The consumers who bought gluten-free cookies were

categorised into 3 groups, such as adolescents (10–19 years), young adults (20–35 years), and middle-aged adults (36–55 years), and asked to fill in their comments on the feedback form.

RESULTS AND DISCUSSION

Table 1: Physical Property.

Parameter	Unit
Weight	45 g
Thickness	8 mm
Diameter	44.45 mm
Spread ratio	5.55 mm

The table 1, shows the physical parameters of each cookies with weight 45 gram (g), thickness 8 millimetre (mm), diameter 44.45 millimetre (mm) and spread ratio 5.55 millimetre (mm).

Table 2: Nutrient Analysis.

Parameters	Unit	Value/100g
Energy	kcal	395.57
Protein	G	6.02
Fat	G	8.21
Carbohydrate	G	74.40
GLUTEN	**G**	**NIL**
Crude fibre	G	1.28

The table 2 shows the presence of various nutrients in 100 grams (g) of gluten-free cookies, with values for each nutrient. Therefore, 100 g of gluten-free cookies has 395.57 kilo calories (kcal) of energy, 6.02g of protein, 8.21g of fat, 74.40g of carbohydrate, 1.28g of crude fibre, and 0g of gluten.

Table 3: Sensory Evaluation.

S.No	Sensory attributes	Possible score	Panellists score	Percentage %	Mean score	Standard deviation
1	Colour	300	270	90%	18	0
2	Appearance	300	283	94.3%	18.86	0.71
3	Texture	300	283	94.3%	18.86	1.3
4	Taste	300	281	93.6%	18.73	0.85
5	Flavour	300	280	93.3%	18.8	1.1

15 panel members assessed the overall score in percentage (percent) of colour at 90 percent, appearance at 94.3 percent, texture at 94.3 percent, taste at 93.6 percent, and flavour at 93.3 percent out of 100 percent, according to the Table 3.

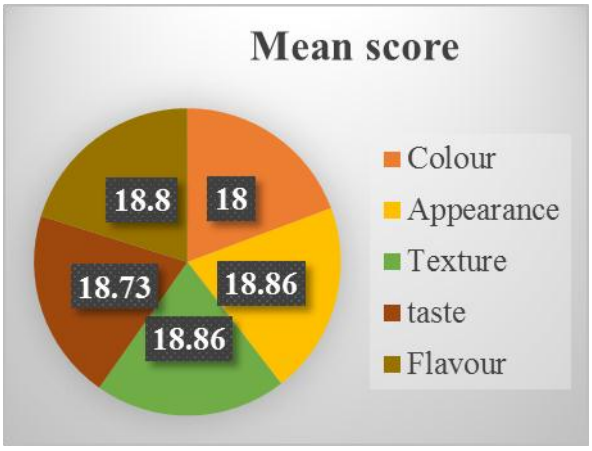

Figure 1: Sensory Feature of the Cookies.

The average score for each sensory feature, such as colour, look, texture, taste, and flavour, is shown in the figure 1. As a result of the sensory examination, each sensory attribute has a mean score of 18 or greater. We can deduce from this sensory evaluation that the gluten-free cookies were more acceptable due to all of the sensory qualities.

Table 4: Microbial Analysis.

Microbes	Unit	1st day	14th day
Total plate count	CFU/g	600	9900
Yeast & Mould	CFU/g	30	130

The above table 4 shows the presence of total plate count and yeast and mould in gluten-free cookies on day 1 and also on day 14. On the first day, the total plate count was 600 CFU/g, the yeast and mould were 30 CFU/g, and on the 14th day, the total plate count was 9900 CFU/g, the yeast and mould were 130 CFU/g. From which we can infer that the microbial count grossly increases day by day, and we can also conclude that the shelf-life of gluten-free cookies is not stable.

Table 5: Shelf-Life Analysis.

Sensory attributes	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Colour	19	19	19	18	18	18	18
Appearance	19	19	19	18	18	18	18
Texture	19	19	18	17	17	16	16
Taste	20	20	20	20	18	18	18
Flavour	20	20	20	20	19	19	19

The tables shows the 7 days score of each sensory qualities like colour, appearance, texture, taste and flavour of gluten-free cookies. From this, it was inferred that there is a slight change in texture from the day 4.

Table 6: Cost Analysis.

INGREDIENTS	QUANTITY	COST (RS)
Quinoa flour	100g	39
Buckwheat flour	75g	25
Butter	100g	46
Sugar	100g	9
Egg white	1teaspoon	2
Baking powder	1g	1
Vanilla essence	1ml	1
Gluten-Free Cookies	30 no's	123
	1 no	**4**

The above mentioned ingredients with quantities yield 30 cookies at a cost of rupees 123. From which the cost of one cookie was calculated, that is the cost of one cookie is Rs.4.

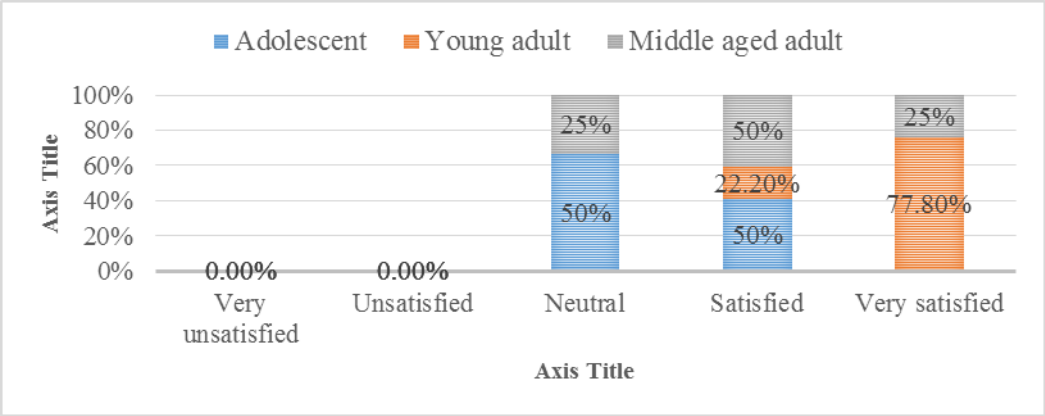

Figure 2: Feedback on Overall Acceptance.

The above figure shows that in adolescents, 50% were satisfied and 50% were neutral. In young adults, 77.8% were "very satisfied" and 22.2% were "satisfied." In middle-aged adults, 25% were very satisfied, 50% were satisfied, and 25% were neutral.

There is a significant relationship between overall acceptance and age group of the consumers ($p<0.05$).

CONCLUSION

The study's ultimate goal was to create gluten-free cookies for people with Celiac Disease (CD), and the cookies achieved that goal because they contained no gluten, according to a lab test. Other nutritional parameters such as physical qualities, sensory evaluation, microbiological count, and gluten-free cookie shelf-life were also calculated. The product was well received during its launch. As a result, a product like gluten-free cookies is required in the current situation because it

provides appropriate nourishment for people suffering from celiac disease as their choices are limited.

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