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RESEARCH ARTICLE

MULTIFLAX CRACKERS FOR TYPE 2 DIABETIC PATIENTS- A MODIFIED FOOD PRODUCT.

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Abstract

Multiflax crackers are developed as a snack for type 2 diabetic patients. The crackers are a healthy modification of traditional South Indian snack 'Thattai'. The modified food product attempts to improve fiber and the carbohydrate source used are such which are beneficial in lowering blood glucose levels such as jowar, whole wheat flour and ragi. The product is low in fat as they are baked compared to traditional product which is fried. Functional foods such as flaxseeds, sesame seeds, garlic are also used in this recipe. 5 point ranking scale was used for evaluation and a standardized product was developed.

Introduction:-

Diabetes as defined by (WHO, 2014) is a chronic disease, which occurs when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces. This leads to an increased concentration of glucose in the blood. According to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India is currently around 40 million and this number is expected to rise to 70 million by 2025.According to (IDF diabetes atlas - 7th edition, 2015) 1 in 11 adults have diabetes (415 million), 46.5% of adults with diabetes are undiagnosed and by 2040, 1 adult in 10 (642 million) will have diabetes.

The product was planned under the Applied Food Science and Product Modification practical in the year 2015-2016. Multiflax crackers are a modification of traditional South Indian recipe 'Thattai' which are deep fried crispy savory snack made out of rice flour. The modified crackers are made out of whole wheat flour, jowar flour, ragi flour. Functional foods such as flaxseeds, sesame seeds and garlic are added to make it healthier for a diabetic patient. The crackers were baked unlike the traditional 'Thattai' which are fried. Therefore, these are low in fat and nutritious for a diabetic patient.

Methodology:-

Developing the food product:-

- The rice flour in the traditional recipe was replaced by whole wheat flour, jowar flour and ragi flour.
- Garlic which acts as a functional food, chili powder, curry leaves and coriander leaves were added to enhance flavor.
- The amount of oil was according to the requirement for baking the product as compared to traditional product in which deep frying method is used. Butter was not used in modified recipe.

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- The modified product also contain flaxseeds which is a functional food, it contains high level of essential omega 3 fatty acid i.e. Alfa Lipoic Acid (ALA), along with protein, fiber and plant compound called lignans that act as an antioxidant when ingested.
- It also contain white sesame seeds , a functional food, an excellent source of copper and a very good source of manganese, also a good source of calcium, magnesium, iron, phosphorus, vitamin B1, zinc, molybdenum, selenium, and dietary fiber.

Table 1:- Ingredients of Traditional and Modified recipes

Thattai		**Multiflax crackers**	
Rice flour	25g	Wheat flour	15g
Fried gram flour	5g	Jowar flour	10g
Bengal gram dal	5g	Ragi flour	5g
Red chili powder	5g	White sesame seeds	1tbsp
Unsalted butter	5g	Flaxseeds	1tbsp
Oil	For deep frying	Green/red chili	2small
Hing	A pinch	Coriander leaves	2 spring
Salt	to taste	Curry leaves	1 spring
		Garlic	3-4 cloves
		Oil	10g
		Salt	to taste

Table 2:- Standardization of the developed food product

INGREGRIENTS	**AMOUNTS**
Wheat flour	15g
Jowar flour	10g
Ragi flour	5g
White sesame seeds	15g
Flaxseeds	15g
Green/red chili	2small
Coriander leaves	2 spring
Curry leaves	1 spring
Garlic	3 small cloves
Oil	10g
Salt	to taste

Figure 1:- Method of preparation

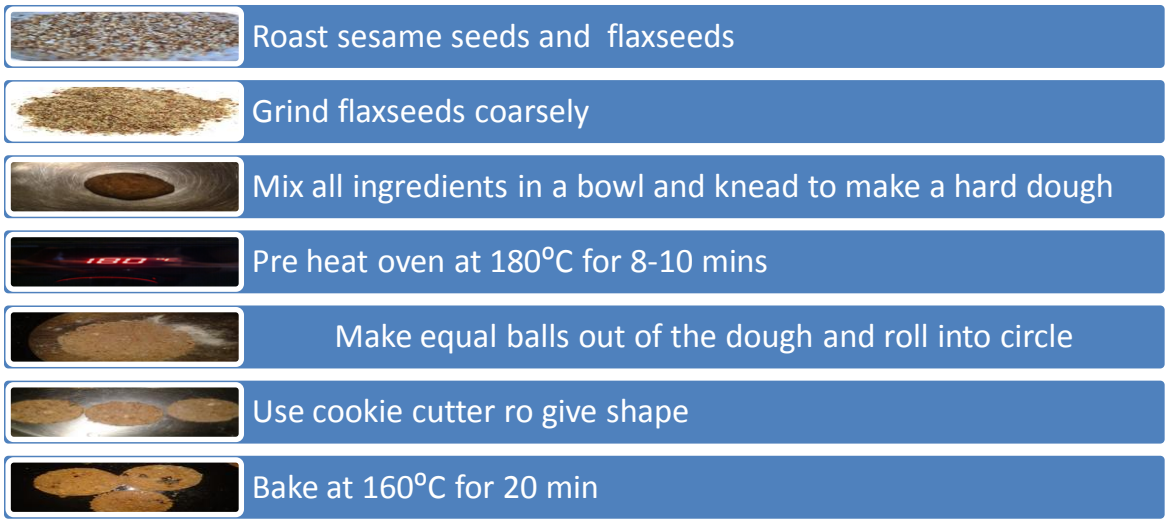


Table 3:- Comparison of nutritive value between traditional product 'Thattai' and modified product 'Multiflax Crackers'

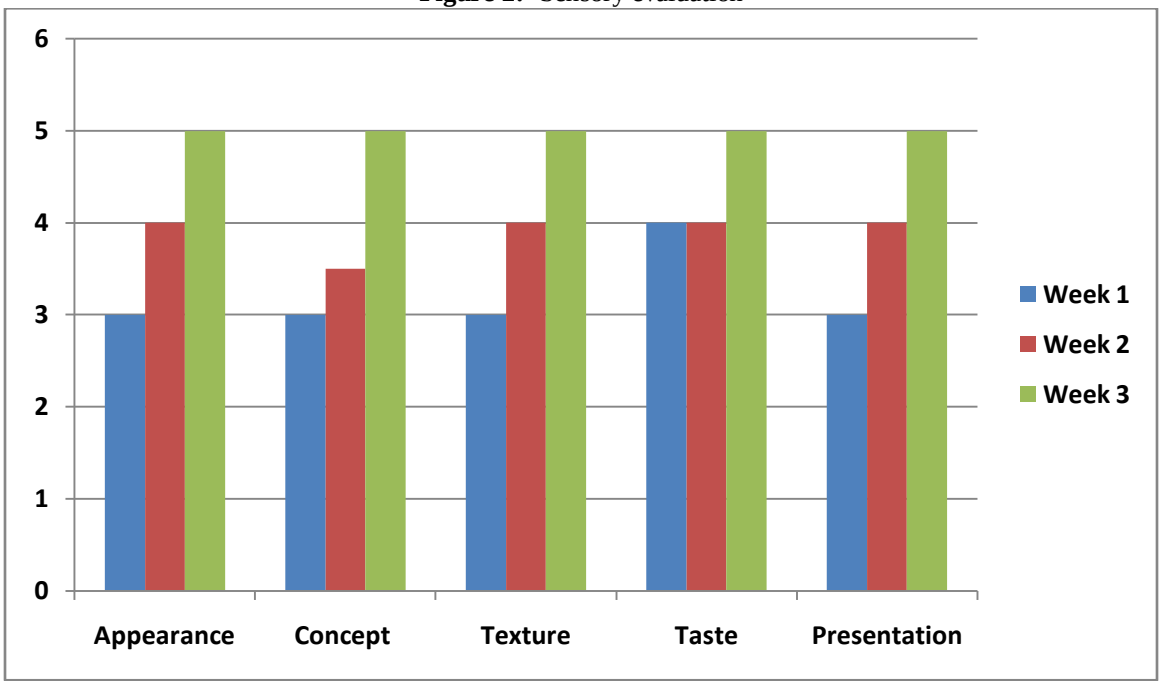
Calculation of product was done with reference to Nutritive Value of Indian Foods and comparision was done between traditional and modified product. (C.Gopalan, 2012).

Nutrient	Unit	Traditional product	Modified product
Energy	kcal	432	389
Protein	gm	4.4	8.7
Carbohydrate	gm	23.8	27.5
Fat	gm	35.5	24.9
TDF	gm	2.4	9.7

Evaluation of the standardized product:-

Multiflax crackers were subjected to sensory evaluation based on 5 point ranking scale for appearance, concept, texture, taste, presentation using 35 panel members (30 naive panel members and 5 expert panel members) . The score were based on the criteria: 5-excellent, 4-very good, 3-good, 2-satisfactory, 1-poor. There was a gradual improvement in the product week after week. In the last week all the panels rated the product as "excellent".

Figure 2:- Sensory evaluation



Result:-

The modified product contains fewer calories compared to traditional product. It is low in fat as it is baked compared to traditional product which is deep fried. The source of carbohydrate in the product helps in controlling blood sugar level in diabetic patient compared to traditional product. The fiber comparison of the product is better in comparison with the traditional product.

Discussion:-

The product contains 3 different types of flours such as whole wheat flour, jowar flour, ragi flour which are healthier option as compared to refined flour. Wheat flour is rich in dietary fiber, selenium, phosphorous, manganese, magnesium, calcium, zinc, copper, folate. Jowar is a very good source of B-vitamins like thiamin and riboflavin. It is also rich in phytochemicals including tannins, phenolic acids and anthocyanins. Ragi is extremely good source of iron, proteins and essential amino acids such as Valine, Methionine, Isoleucine, Threonine and Tryptophan. It contains essential nutrients like iron, calcium, potassium, and phosphorous. Has high content of proteins.

A study was conducted on glycemic response to wheat flour. The blood glucose response to feeding 50-g carbohydrate portions of white and wholemeal bread and white spaghetti was studied in a group of nine diabetic subjects. Blood glucose rise after consumption of white and wholemeal bread were identical, but the response after spaghetti was markedly reduced. These results emphasize that food form rather than fiber may be important in determining the glycemic response and that pasta may be a useful source of carbohydrate in the diabetic diet. (Jenkins, 1983)

Another study by (McKeown NM, 2004) state that people who eat three or more servings of whole grains a day, especially from high-fiber cereals have less likelihood to develop insulin resistance and the metabolic syndrome, common precursors of both T2DM and CHD. Rave and Roggen investigated the potential of a whole-grain based dietary product (WG) in comparison to a nutrient-dense meal replacement product (MR) in a randomized two-way cross-over study. The comparison between both groups revealed that fasting serum insulin ($P = 0.031$) and HOMA insulin resistance score ($P = 0.049$) improved better with WG than with MR. It was concluded that WG favorably influences metabolic risk factors (like insulin resistance) for T2DM independent from the amount of body weight lost during a hypo-energetic diet. (Rave K, 2007).

A team of German researchers followed over 16,000 adults for a period of seven years and found that those who ate cereal fiber the most (relative risk for extreme quintiles, 0.72 [95% confidence interval, 0.56-0.93]), had a 27% lower risk of developing T2DM than those who ate the least. Components of whole grains, including magnesium, fiber, vitamin E, phytic acids, lectins, and phenolic compounds, are believed to contribute to risk reduction of T2DM as well as lowering blood glucose and blood insulin levels. In studies that examined the source of fiber, researchers found that fiber from whole grains, but not from fruit or vegetable sources, appears to exert the protective effect in reducing risk for developing T2DM.

A review of randomized control trials, in diabetic subjects showed that low GI diets compared to high GI diets lowered protein markers of glycemic control measured as HbA1c decreased by 0.5% (95% CI −0.8 to −0.2; $P< 0.001$). This 0.5% reduction is clinically significant, as it corresponds to a lower dosage of medications for newly diagnosed patients (Sievenpiper JL, 2009) and the UK Prospective Diabetes Study (UKPDS) suggests that a 1% reduction in mean HbA1c levels corresponds to a 21% reduction in risk for deaths related to diabetes and its complications (Rury R Holman, 1995). A recent epidemiological study among urban adults has shown that higher refined grain consumption is associated with dyslipidemia (low HDL and high TG), metabolic syndrome, and increased risk for type 2 diabetes.

The product also contain flaxseeds which contains high level of essential omega 3 fatty acid i.e. Alfa Lipoic Acid (ALA), along with protein, fiber and plant compound called lignans that act as an antioxidant when ingested. In this recipe flaxseeds has been added in ground form and grinding flaxseeds makes the inner compounds more accessible. Lignans present in flaxseeds are known to improve the blood sugar level in type 2 diabetes, having flaxseeds on a daily basis can help maintain blood sugar levels over an extended period of time.

The effects of ingestion of flaxseed gum on blood glucose and cholesterol, particularly low-density lipoprotein cholesterol, in type 2 diabetes were evaluated. Flaxseed gum was incorporated in wheat flour chapattis. Sixty patients of type 2 diabetes were fed a daily diet for 3 months, along with six wheat flour chapattis containing flaxseed gum (5 g), as per the recommendations of the American Diabetic Association. The control group (60 individuals) consumed an identical diet but the chapattis were without gum. Results showed a decrease in low-density lipoprotein cholesterol from 110±8 mg/dl to 92±9 mg/dl ($P=0.02$). The study demonstrated the efficacy of flax gum in the blood biochemistry profiles of type 2 diabetes. (Goutam Thakur, 2009).

In a randomized, cross-over study overweight or obese men and postmenopausal women ($n = 25$) with pre-diabetes consumed 0, 13, or 26 g ground flaxseed for 12 weeks. At the end of the study it was concluded that flaxseed intake decreased glucose and insulin and improved insulin sensitivity as part of a habitual diet in overweight or obese individuals with pre-diabetes. (Andrea M. Hutchins, 2013)

The product also contain white sesame seeds an excellent source of copper and a very good source of manganese, they are also a good source of calcium, magnesium, iron, phosphorus, vitamin B1, zinc, molybdenum, selenium, and dietary fiber. In addition to these important nutrients, sesame seeds contain two unique substances: sesame and sesamolin. Both of these substances belong to a group of special beneficial fibers called lignans, and have been

shown to have a cholesterol-lowering effect in humans, and to prevent high blood pressure and increase vitamin E supplies in animals. Sesame has also been found to protect the liver from oxidative damage.

In an open label trial with two intervention periods comprised 22 male and 18 female patients, 45–65 years old, with mild to moderate hypertension and diabetes. Sesame oil was supplied to the patients, who were instructed to use it in place of other cooking oils for 45 days. Blood pressure (BP), anthropometric measurements, plasma glucose, glycated hemoglobin (HbA1c), lipid profiles [total cholesterol, low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol, and triglycerides (TG)], lipid peroxidation [thiobarbituric acid-reactive substances (TBARS)], electrolytes (sodium, potassium, and chloride), and enzymic (superoxide dismutase, glutathione peroxidase, and catalase) and nonenzymic (vitamin C, vitamin E, β-carotene, and reduced glutathione) antioxidants were measured at baseline and after 45 days of sesame oil substitution. The same patients were then switched over to other oils like palm or groundnut oils as their regular oils at random for another 45 days, and the investigations were carried out again at the end. The results indicated that substitution of sesame oil as the sole edible oil has an additive effect in further lowering BP and plasma glucose in hypertensive diabetics (D. Sankar, 2006).

In another open label study included sixty type 2 diabetes mellitus patients divided into 3 groups, receiving sesame oil (n = 18), 5 mg/day (single dose) of glibenclamide (n = 20), or their combination (n = 22). The patients were supplied with sesame oil except glibenclamide group, and instructed to use approximately 35 g of oil/day/person for cooking, or salad preparation for 60 days. 12 h-fasting venous blood samples were collected at baseline (0 day) and after 60 days of the experiment for various biochemical analysis. The results showed that sesame oil exhibited synergistic effect with glibenclamide and can provide a safe and effective option for the drug combination that may be very useful in clinical practice for the effective improvement of hyperglycemia (Devarajan Sankar, 2010).

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