DEVELOPMENT OF MUFFIN WITH DIABETIC FRIENDLY INGREDIENTS

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ABSTRACT

Background: *Diabetes is one of the major health problems is the world. India is considered as the diabetic capital of the world. It commonly occurs in middle adulthood (45-60 years), people suffering from diabetics often have craving of having something sweet but cannot have it as their ingredients have a high Glycemic Index and low in fibre content, which instantly leads to rise in the blood glucose level in the body and can further lead to worsening of the symptoms. Developing bakery goods with healthier alternative can benefit diabetic people to overcome the craving this craving.* **Objective:** *The work was conducted to develop muffins with diabetic friendly ingredients and to conduct its sensory, nutritive and microbial analysis.* **Methodology:** *Experimental study was conducted to develop healthier variety of muffins which is one of the most commonly consumed bakery product. The work was conducted in the laboratory of Institute o f Hotel Management, Pusa, New Delhi. The base ingredients used were Buckwheat, Flaxseed and Dates. On finalization of the product nutritive value, sensory evaluation on 5-point hedonic scale by trained panel (n=5) and semi trained panel (n=25) and 3 days shelf life estimation of the developed product was done.* **Results:** *The final product was made by using buckwheat and refined flour (50%), flaxseed and dates. The nutritive value of the product as per 100 grams was energy (505 Kcal), protein (9.4 gm), carbohydrate (36.84 gm), fat (32.96 gm) and total dietary fibre (6.58 gm). For overall acceptability of the product majority (80%) of trained panel extremely liked the product and majority (56%) of semi trained panel extremely liked and 32% neither liked or disliked the product.* **Conclusion:** *The craving for sweet cannot be a danger if healthy alternatives are made a part of days meal. Inclusion of healthy ingredients in tempting snacks or products can be beneficial for people suffering from lifestyle disorders.*

Key Words*: Diabetic Muffin, Dates, Flaxseed, Buckwheat, Glycemic Index, Fiber*

INTRODUCTION

Diabetes is a metabolic disorder which is characterized by high blood glucose levels which can be due to a decreased ability or complete inability of the tissues to utilize available carbohydrate. This disorder is caused due to deficient or diminished effectiveness of the hormone insulin which is produced by beta cells of the Islet of Langerhans of pancreas. According to World Health Statistics conducted by WHO in 2012 it was reported that 1 out of 10 men and women above 25 years of age have high blood sugar levels. 50% of the world diabetic population lives in 3 countries namely China, India & USA with 98.4 million, 65 million and 24.4 million respectively (IDF Diabetes Atlas, 2019).

The two major forms of diabetes are Type 1 (Insulin dependent Diabetes Mellitus) and Type 2 (Non Insulin dependent Diabetes Mellitus) diabetes. Type 1 account for 5-10 percent of the diagnosed cases of diabetes. It is of relatively infrequent occurrence and generally seen prior to the age of 20 years although it may occur at any age. The disease usually has an abrupt onset and the abnormality of carbohydrate metabolism is severe due to lack of endogenous insulin to control blood glucose levels. Type 2 diabetes usually occurs in middle life beyond the age of 40 years although it may also occur in the younger age group. It accounts for 90-95 percent of all the diagnosed cases of diabetes. Genetic and environmental factors are the most common risk factors. It often results from a combination of insulin resistance and beta cell failure. A large number of type 2 diabetes may, therefore eventually need exogenous insulin for controlling blood glucose levels (Khanna et al., 2016).

As per World Health Statistics released by World Health Organization in 2012, over 1 in 10 men and women aged 25 years and above have high blood sugar. India, the second most popular country of the world, has been severely affected by the global diabetes epidemic. As per International Diabetes Federation (2013), approximately 50 % of all the people with diabetes live in just three countries: China (98.4 million), India (65.1 million) and the USA (24.4 million) (IDF Diabetes Atlas, 2019).

According to the researchers, it has been mentioned that India is home to nearly 62 Million diabetics and by 2030 nearby 9% of the total population of India is likely to be affected by diabetes and many of them being overweight or obese. This makes them three times more at risk for developing type 2 diabetes than normal weight people (Jeppesen et al., 2013).

The management of diabetes requires multifaceted approach Medical Nutrition Therapy (MNT), physical activity, medications and education. It is well known that nutrition plays a very important role in management of diabetes thus, keeping a check on daily diet of a diabetic is very essential.

The nutrient which has to be worked upon is carbohydrate- introduction of complex forms instead of simple sugars. The complex sugars breakdown more slowly to release glucose, soluble fiber present in oats, barley, fruits and legumes have shown to lowering fasting blood sugar and glycosuria and improves sensitivity to insulin.

Diet with low glycemic index (GI) improve the prevention of coronary heart disease in diabetic and healthy subjects. In obese or overweight individuals low-glycemic index meals increases satiety and facilitate the control of food intake (Rizkalla, et al 2002). The advantages of eating a low glycemic food is that your blood sugar will not rise as rapidly. Low glycemic index produces a steadier rise in blood sugar and fiber in this food helps the person to give satiety (Glatter, 2014).

Diabetic individuals usually have cravings for sweets but due to medical conditions cannot have it regularly as they are high in GI i.e. >55 and are low in fiber content or without. Providing a healthy sweet option to diabetics becomes an area of concern or interest so that they can relish and overcome the craving. For this exploring the healthier varities becomes an area to explore on. Food groups like cereals, oils seeds offers some such ingredients which have good amount of fibre in them thus which helps in maintaining blood glucose level.

Buckwheat (*Fagopyrum esculentum*) commonly known as kuttu is a multifarious pseudodocereal with high nutritional benefits, without gluten rich in water soluble fibre, contains high-quality proteins, unsaturated fatty acids and has appreciable mineral and vitamin content. Buckwheat seeds contain various phenols, bioflavonoids including rutin and sugar cyclitols, flavoinds which act as anti-inflammatory, anti-allergic, provide protection against cardiovascular disease and treat diabetes. The glycosides and alkaloids present in kuttu seeds are used as anti-microbial agents and the former is used in the treatment of cancerous cell (Bhaduri & Prajneshu, 2016). Buckwheat is highly nutritional food component that has been shown to provide a wide range of beneficial effects. Health benefits attributed to buck wheat include plasma cholesterol level reduction, neuroprotection, anticancer, anti-inflammatory antidiabetic effects, and improvement of hypertension condition (Zielinski et al 2009). Moong and buckwheat khichdi are a variation of the traditional khichdi in which rice is replaced by buckwheat due its low GI i.e. 51 and high fibre content (Dalal, 2021).

Flaxseed (*Linum usitassimum L.*) belonging to family lineaceae, is a blue flowering annual herb that produces small flat seeds varying from golden yellow to reddish brown color. Flaxseed possesses crispy texture and nutty taste. Flaxseed is also known as linseed. Flaxseed is often called flax when consumed by human while linseed denotes when it used for industrial application (Morris, 2007). Flaxseed is a functional food ingredient because as provides oil rich in omega-3, digestibility proteins and lignans and also in addition to this it is one of the richest sources of alpha linolenic acid oil and lignans. Flaxseed is an essential source of high-quality protein and

soluble fibre (Beranacchi et al., 2014). A low dose of flaxseed i.e 13g day for 12 weeks was associated with a significant reduction in insulin resistance (Bhardwaj et al., 2015). Being good source of alpha-linolenic acid, fibre and flax lignans it has potential health benefits like reduction of cardiovascular disease, atherosclerosis, diabetes, cancer, arthritis, osteoporosis, autoimmune and neurological disorders. A daily intake of tablespoon of grounded flaxseed for a month appears to improve fasting blood sugars, triglycerides, cholesterol and HbA1c levels in diabetics (Greger, 2013). In a study done by Sheth and Sengupta (2015) flaxseed was used as one of the ingredients in making of muthiya for diabetics, which helped in enriching the traditional muthiya with fibre. Thus such product development adds value to commonly consumed product for specific groups.

Dates (*Phoenix dactylifera*) are one of the members of the palm family Arecaceae, or Palmae (Zohary et al., 2012). There are more than two hundred varieties of dates available worldwide (Amer, 1994). It is the main crop in Egypt, Saudi Arabia, and Middle Eastern countries. It is thought that the native origin of dates is around the Persian Gulf, and has been cultivated from Mesopotamia to prehistoric Egypt as early as 4000 BCE (Chao & Krueger, 2007). Date palm is one of the mankind's oldest cultivated plants. Dates are rich in carbohydrate (total sugar 44-88%), salts, minerals, vitamin, fatty acids (0.2-0.5%), proteins (2.3-5.6%), fibre (6.4 -11.5 %) (Shahib & Marshall, 2003). In a vitro and vivo study conducted by Rainey (2016) the glycemic index - 46.18 was reported for dates which makes it suitable for use in product development for diabetics.

Regular sweets which are high in sugar content as per the basic nature makes it very difficult for people suffering from diabetes to control their craving. Keeping health as a priority individual tries to control the craving which also has its psychological impact. With demand for healthy products on rise and a move towards natural additives development of products with natural ingredients and with balanced glycemic index use of such ingredients seems to be promising in development of healthier alternatives.

Muffins are one such food product that is relished by many belonging to various age groups. A standard muffin is made up of refined flour which has high glycemic index and thus not recommended to diabetics. Development of muffin with diabetic friendly ingredients namely- dates, buckwheat and flaxseeds will provide healthier alternative to munch on. Muffins were selected as they are handy foods easy to carry and consume. This will decrease the G.I. add fiber which helps in delayed utilization of glucose and natural sweetness. Thus the objectives of the work were.

- To develop diabetic friendly muffin.
- To calculate nutritive value of the developed product.
- To determine shelf life of the developed product.

- To conduct sensory evaluation of the developed product.
- To design a label for the developed product.

METHODOLOGY

Research Design: Experimental study was conducted to develop diabetic friendly muffin from buckwheat, refined wheat flour, butter, flaxseed, egg and its acceptability was evaluated.

Locale: The product development was done in home kitchen, New Delhi. Sensory Evaluation was done by trained and semi trained panel of Institute of Hotel Management, Catering and Nutrition, Pusa, New Delhi. Shelf life of the product development was done in Microbiology Laboratory of Institute of Hotel Management, Pusa, New Delhi.

Sampling Design: The ingredients for product development were procured from Krishna Nagar, East Delhi. For sensory evaluation, purposive sampling was done thirty panel members were selected. Panel members were divided into two groups: Trained Panel (n=5) and Semi-Trained panel (n=25). The study was conducted from January 2018 to April 2018.

Tools and Techniques: Tools used for product development were, spatula, sieve, mixer, muffin tray, measuring cup, measuring spoon, bowls. For calculating nutritive value of the developed product, Indian Food Composition Table; Longvah et at., (2017) was used. For sensory evaluation 5-point hedonic scale was used. For shelf life analysis of the developed product culture media, test tubes, test tube stand, sterile petri dishes, sterile test tubes, conical flask, 1ml sterile pipettes, measuring cylinder, Bunsen burner, spatula, parafilm slips, marker, autoclave incubator and laminar airflow were used.

The product was developed in five phases, skills were developed for making standard recipe. The trials were conducted with the selected ingredients. After the development of final product, nutritive value (energy, protein, carbohydrate, fat and total dietary fibre) was calculated. Shelf life of the product was done by the Plate Count method to measure microbial numbers. Spread plate technique was used in which a ten-fold serial dilution process was used in which 1ml of the sample was transferred to the 9ml of the diluent to get 1:10 dilution. Sensory Evaluation was conducted by 5 point Hedonic Rating Scale; 5- Extremely Like (EL), 4- Like (L), 3- Neither Like or Dislike (NLND), 2- Dislike (D), 1- Extremely Dislike (ED). The attributes evaluated were appearance, taste, aroma, texture and overall acceptability. Panel members were asked to rinse their mouth with water for evaluation.

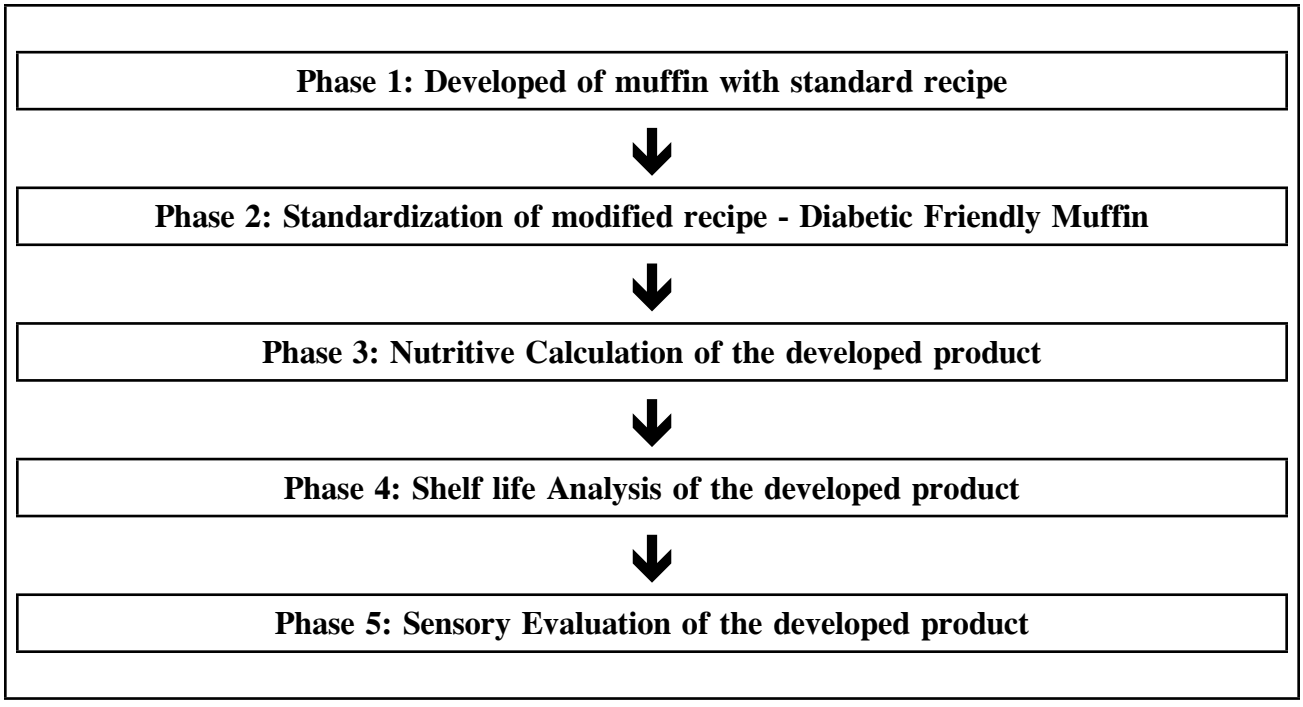

Figure 1: Phases of Product Development

RESULTS AND DISCUSSION

Product Development: For development of diabetic friendly muffin the ingredients of standard muffin i.e. half of refined wheat flour was replaced with buckwheat flour, castor sugar was replaced with dates and margarine with Butter. Trials were carried out to fulfill various parameters i.e. fluffiness, softness and sweet taste.

Trial A was done by reducing refined wheat flour to half of the quantity along with same amount of buckwheat flour; dates, flaxseeds, refined oil, milkmaid and milk were added to give desired texture. Product came out to be heavy and not fluffy thus in Trial B milkmaid and milk were replaced by egg and the quantity of oil was reduced to half. Muffins in this trial were fluffy but less sweet which was attributed to milkmaid. Thus in Trial C amount of dates were increased by 10 gram to get the desired sweet taste (table 1).

The muffins developed in this trial were hard as reduced amount of oil was unable to handle increased quantity of dates. So in the next trail i.e Trail D butter was added instead of margarine as in standard recipe to make the muffin soft in texture. Also the quantity of dates was increased further by 20 gram. With Trial D the planned product was finalized and was subjected to next level assessments. Refined Wheat Flour contains only 0.3g/100g of fibre, it has a high Glycemic Index whereas buckwheat contains 8.6g/100g, flaxseed contains 4.8g/100g, dates 3.9g/10g. all these contributed to the fibre content of the developed product (Longvah et al., 2017).

Table 1: List of Ingredients and Trials for Product Development

Ingredients(g/ml)	Standard	A	B	C	D
Refined Wheat Flour(g)	50	25	25	25	25
Castor Sugar(g)	50	-	-	-	-
Margarine(g)	50	-	-	-	-
Egg(g)	50	-	50	50	50
Buckwheat flour(g)	-	25	25	25	25
Dates(g)	-	20	20	30	50
Flaxseed(g)	-	13	13	13	13
Milkmaid(ml)	-	10	-	-	-
Milk(ml)	-	5	-	-	-
Oil(ml)	-	10	5	5	-
Butter(g)	-	-	-	-	50

Nutritive Value: Nutritive value of the muffin (100 gram) prepared by standard recipe was found to be energy (545.4 Kcal), protein (8 gm), carbohydrate (57.7 gm), fat (28.7 gm) and total Dietary Fiber (0.92 gm). For the developed product i.e. Diabetic Friendly Muffin nutritive value was found to be energy (505 Kcal), Protein (9.4 gm), Carbohydrate (36.84 gm), Fat (32.96 gm) and Total Dietary Fiber (6.58 gm). The developed product contained seven times more fibre than standard one where fiber was less than one gram. Increased amount of fibre will help in delaying the utilization of glucose which is beneficial for diabetes and thus the sweet snack can be enjoyed. To provide desired calories for a snack one serving of Diabetic Friendly Muffin was kept as 50 gram. Nutritive value of which is presented in table 2.

Table 2: Nutritional Evaluation of the Developed Product

Nutrient	Standard Muffin (100g)	Diabetic Muffin (100g)	Diabetic Muffin (50g)
Energy (kcal)	545.4	505	252.5
Protein (g)	8	9.4	4.7
Carbohydrate(g)	57.7	36.84	18.42
Fat(g)	28.7	32.96	16.48
Total Dietary Fibre (g)	0.92	6.58	3.29

Sensory Evaluation: Sensory Evaluation results of the developed product by Trained Panel revealed that majority of subjects (60%) extremely liked the appearance of the product followed by 40% who liked it. Majority (80%) extremely liked the taste followed by few (20%) who liked the taste of the product. Regarding texture equal percentage (40%) extremely liked and liked the product texture followed by few subjects (20%) who neither liked or disliked it. For aroma a majority (60%) liked it followed by 40% who liked it extremely.

For overall acceptability majority (80%) extremely liked the developed product followed by 20% who just liked it. The mean scores for trained and semi trained are presented in the table 3.

Table 3: Mean of Sensory Evaluation Scores by Trained and Semi-Trained Panel

Diabetic Friendly Muffin		
Sensory attributes	**Trained panel (n=5 Mean± SD**	**Semi Trained Panel (n=25) Mean± SD**
Appearance	4.6 ± 0.54	3.92 ± 0.70
Taste	4.8 ± 0.44	3.84 ± 0.8
Texture	4.2 ± 0.83	4.08 ± 0.81
Aroma	4.4 ± 0.54	3.64 ± 1.03
Overall Acceptability	4.8 ± 0.44	3.8 ± 0.64

Data on sensory evaluation by semi trained panel revealed that for the appearance majority (52%) liked followed by 28% who neither liked or disliked and very few (20%) who extremely liked the appearance of the developed muffin. For taste majority (48%) liked it followed by 28% who neither liked it not disliked, very few subjects (20%) extremely liked the taste and only (4%) of subjects disliked the taste of the product. The subjects were healthy students, probably if diabetics who have to keep a check on their snacks were selected for sensory the results for this attribute would have varied. Regarding texture majority (48%) of subjects liked it followed by 32% who extremely liked the texture, very few subjects (16%) neither liked or disliked and only (4%) of subjects disliked the Texture of the product. For aroma majority of subjects (52%) liked the Aroma 16% extremely liked and same percentage neither liked or disliked, only (12%) of disliked the Aroma also few of the subjects (4%) extremely disliked aroma of the product. For overall acceptability of the product majority (56%) liked it followed by 32% who neither liked nor disliked it and to very few subjects (12%) extremely liked it.

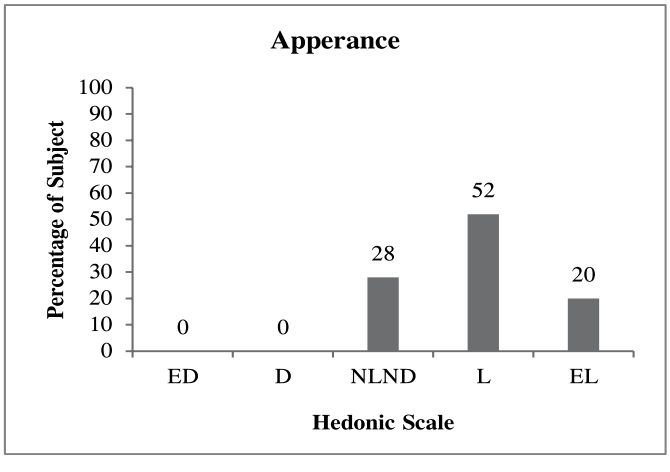

Figure 2: Sensory Evaluation of Appearance

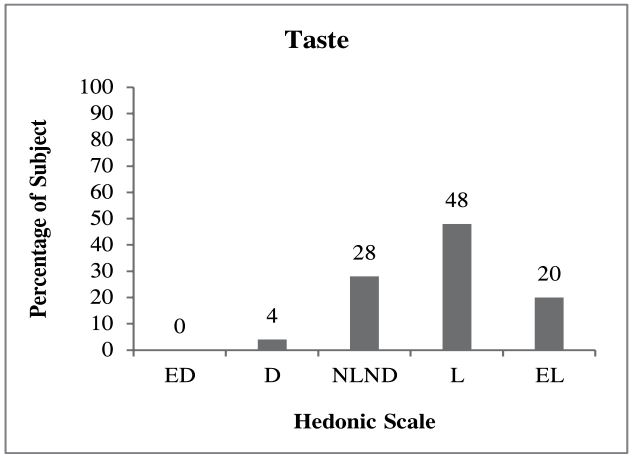

Figure 3: Sensory Evaluation of Taste

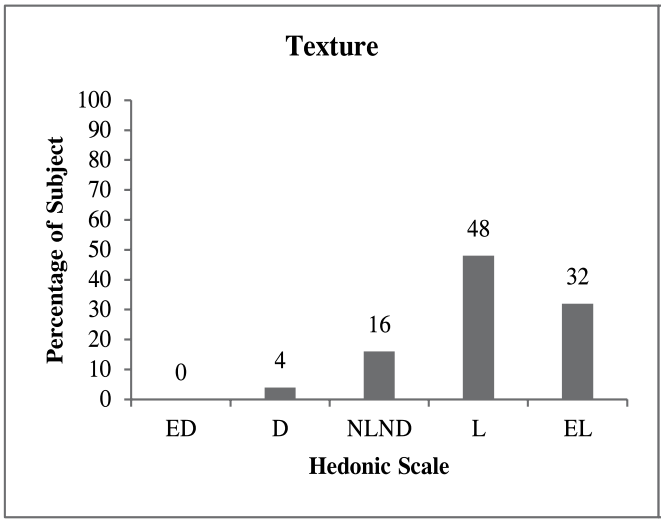

Figure 4: Sensory Evaluation of Texture

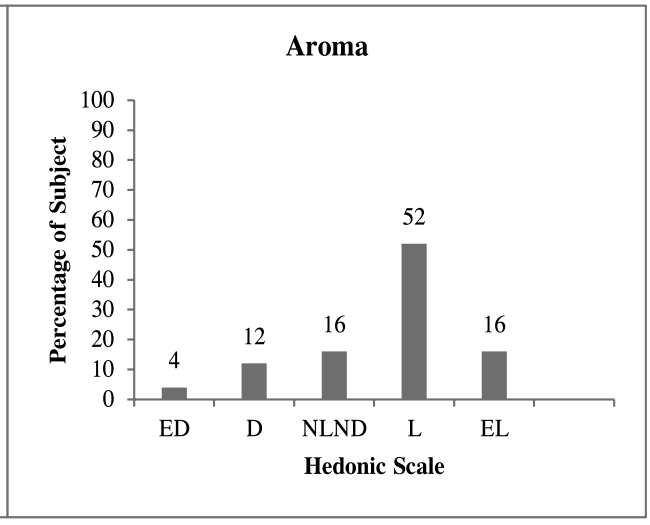

Figure 5: Sensory Evaluation of Aroma

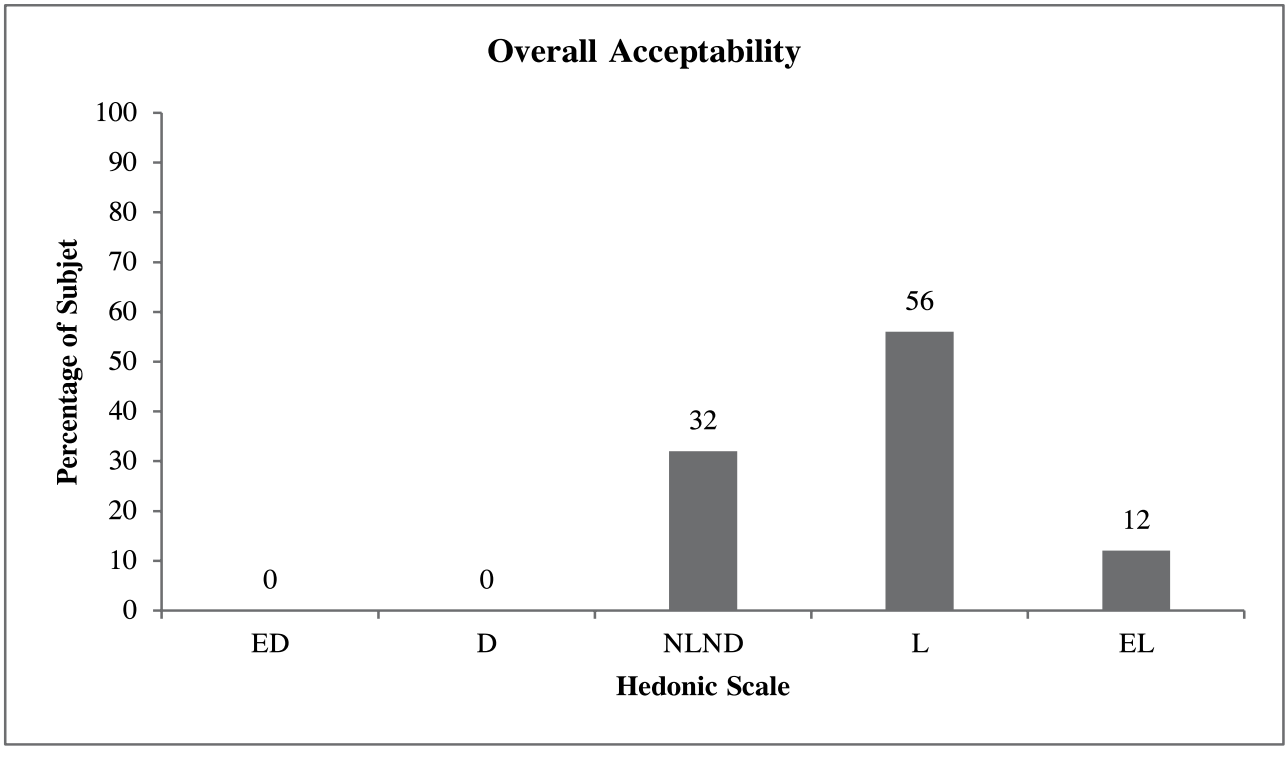

Figure 6: Sensory Evaluation of Overall Acceptability

Shelf Life Analysis: Shelf life analysis was done for three days and no colonies were observed for that period. Thus, the developed product can be kept safely for three days in the refrigerated condition.

Food label: The developed product label comprised of name of the product, ingredients, allergen information nutritive information (energy, proteins, carbohydrate, fat, fiber), net weight (100 g) units (2) and cost (Rs. 20).

CONCLUSION

With the ever going increase in prevalence of lifestyle disorders worldwide and our country coming in umbrella of diabetic capital it becomes alarming to take necessary actions. Action plan do exist but what is important is the implementation. People are aware of the adverse health effects of diabetes, but the basic human nature of craving for food cannot be overlooked. The market is flooded with all kinds of convenience food and so do the purchasing power over the time of various segments is on rise. With the people becoming health conscious, aware it becomes responsibility of the experts from various areas to energize their skills in availability of healthy snack options for people suffering from lifestyle disorders and also for general population so that the nation progresses with healthy individuals. This provides an opportunity for entrepreneurs with skills on nutrition and culinary sciences to develop healthy alternatives to meet the sweet cravings of diabetics. With that in view diabetic friendly muffin was developed with buckwheat which contains fibre, flaxseeds and dates for natural sweetness. The developed product was found to be nutritionally better in terms of providing fibre. On sensory evaluation the product was found to be acceptable by trained and semi trained panel. The shelf life was found to be for three days in refrigeration storage. The information provided on the label will help consumer to make better choice. Thus the product will be able to satisfy the sweet craving of the diabetics and health conscious consumers with good taste and improved nutrition profile.

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