International Journal of Food Science and Nutrition
ISSN: 2455-4898; Impact Factor: RJIF 5.14
Received: 01-08-2020; Accepted: 15-08-2020; Published: 02-09-2020
www.foodsciencejournal.com
Volume 5; Issue 5; 2020; Page No. 01-05

Development and quality evaluation of Nutri rich bars using flaxseed and pumpkinseed

Ch Kranthi Kiran[1*], Bhaskar V[2], Srinivas Maloo[3]
[1-3] Department of Food Technology, University College of Technology, Osmania University, Hyderabad, Telangana, India

Abstract
Functional foods are an emerging field in food science due to their increasing popularity among health conscious consumers. Flaxseed is cultivated in many parts of world for fiber, oil as well as for medicinal purposes and also as nutritional product. It serves as the best omega 3 fatty acid source to the non-fish eaters. The seeds of pumpkin (Cucurbita sp.) are generally considered to be agro-industrial wastes and discarded. With the discovery of their richness in protein, fibre, minerals, polyunsaturated fatty acids and phytosterols, they are being regarded valuable for the food industry. Considering the importance and health benefits of flax seeds and pumpkin seeds they are utilized in the preparation of energy bars. The energy bars are prepared using different ingredients like foxtail millets, oats, flax seeds and pumpkin seeds. Jaggery is used as sweetener. Four different samples are prepared with different composition of flax seeds and pumpkin seeds in equal proportions (1:1) and replaced with oats at 10%, 15%, 20% and they are compared with control sample which is free from both seeds powder. Foxtail millets and oats are used common in all samples. The energy bars were sensory evaluated by Nine Point Hedonic Scale. The nutritional composition of product was chemically analyzed by using the AOAC (2005) method. On the basis of sensory evaluation sample B is most acceptable with regards to overall acceptability. The proximate compositions of the flax seed and pumpkin seed powder were analyzed. The fat and protein content increased with increase in substitution level of seed powder. The nutritional compositional of these seed powders indicates that if it is used as a supplement, it can provide good large amount of nutrients. It can be incorporated to develop a value added product. Hence it can be exploited for its nutritional value.

Keywords: phytosterols, flaxseed, pumpkinseed, foxtail millet, energy bar, omega-3 fatty acid, free fatty acid, sensory evaluation

Introduction
Consumers demand and desire the health foods, which are portable, convenient and proportioned as well (Sloan 2005). Often, many options aren't available that are minimally processed, rich in nutrients and tastes good. Energy bars, a food product that fits these criteria, continue to increase in sales according to the ACNielsen Market Track (Burn 2007). Due to growing consumer demand for healthy, natural and convenient foods, attempts are being made to use flaxseed, pumpkinseed, oats and foxtail millets which are good source of different nutrients.

Flax (Linum usitassimum) belonging to family Lineaceae, is a blue flowering annual herb that produces small flat seeds varying from golden yellow to reddish brown color. Flaxseed is also known as linseed and these terms are used interchangeably. Presently, flaxseed has new prospects as functional food because of consumer's growing interest for food with superb health benefits. Owing to its excellent nutritional profile and potential health benefits, it has become an attractive ingredient in the diets specially designed for specific health benefits. Flaxseed serves as the best omega 3 fatty acid source to the non-fish eaters.

Pumpkins (Cucurbit sp.) belonging to the Cucurbitaceae family are grown widely around the world as a vegetable. Pumpkin seed butter is considered as a great alternative to peanut butter. Major US food stores such as Costco, Trader Joes and Walmart sell myriad varieties of pumpkin seed-based food products, viz. granola chunks, tortilla chips, vegetable salad, sourdough bread, cookies and quinoa salad. Pumpkin seeds and derived oil comprise a multi-million dollar industry in Europe. Now, grocery stores are also selling these seeds as baked, sprouted, fermented, pumpkin protein concentrate and pumpkin protein isolate, as their richness in protein, iron, zinc, manganese, magnesium, phosphorous, copper, potassium, polyunsaturated fatty acids, carotenoids and c-tocopherol is beginning to surface.

Materials and Methods
Materials
The raw materials namely flax seeds, pumpkin seeds, foxtail millets, oats and jaggery which are used to prepare value added energy bars.

Preparation of Energy Bars
Weighing: Select the fine raw materials which are free from contaminants, broken kernels and weigh all the ingredients as per recipe.

Roasting: Roasting is done to reduce the moisture content and improve the flavor of the ingredients. Here oats, pumpkin seeds and flax seeds are roasted till it gets slightly brown color.

Grinding: Grinding of the flax seeds and pumpkin seeds to fine powder so that the energy bar becomes smooth and soft and adds good appearance to the bar.

Preparation of jaggery syrup: Jaggery is used as sweetener. Jaggery syrup is prepared by heating the jaggery at (107 – 110) °C till it reaches hard ball point. At this temperature jaggery melts and form syrup. Stir continuously so that no lumps are formed and till hard ball point is reached. Drop some syrup in a bowl of cold water. It will

sink to the bottom and solidify. This is the right stage for the jaggery syrup formation.

Mixing: Addition of ingredients to the syrup and mix it uniformly so that all the ingredients mix properly and form thick paste.

Spreading: After that Spread it on a plate uniformly so that the thickness of the bars will be uniform throughout the sheet.

Sheeting: Make cuts on the sheet to form desired shapes for the energy bar.

Cooling: Allow it to cool and become dry at 38°C. After drying separate the pieces from the sheet and allow it to cool for some more time.

Packaging: Finally Packaging of the energy bars under different packaging material like high density polyethylene film and low density polyethylene film.

Storage: Store packed product under room temperature for the shelf life studies. Samples are collected after regular interval of time for determination of change in moisture content and other physical and chemical changes in the product.

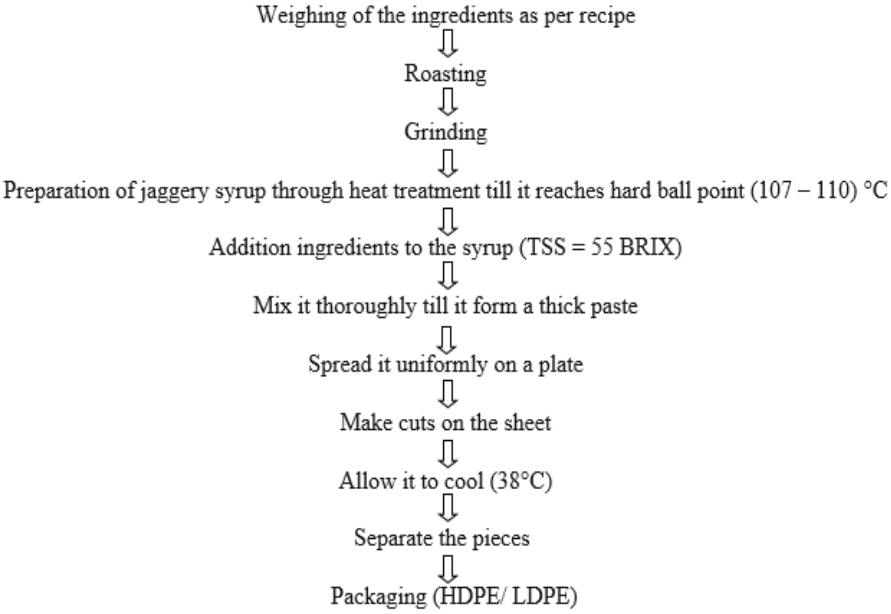
Hard Ball point: Hard ball is a stage in syrup making. When jaggery melts, the water evaporates away and concentration of sweetener increases with increase in temperature. For the jaggery, we are looking for the hard ball stage which is at (107 – 110) °C. Drop some syrup in a bowl of cold water. It will sink to the bottom and solidify. This is the right stage for the jaggery syrup formation.

Table 1: Formulation of different samples (per each bar)

Ingrident	Control	Sample A (10%)	Sample B (15%)	Sample C (20%)
	%	%	%	%
Oats	55	45	40	35
Jaggery	25	25	25	25
Foxtail Millets	20	20	20	20
Flax seeds	-	5	7.5	10
Pumpkin seeds	-	5	7.5	10

Note: Mixture Flax seed and Pumpkin seed are taken in equal proportion (1:1)

Flow Chart for the Preparation of Energy Bars



Physico-Chemical Analysis

Determination of moisture content

Procedure

Weigh accurately about 10 grams of sample in petri plate dishes. Place the dish in the hot air oven maintained at 105°C temperature and allow it to dry atleast for 3 hours and the cool in a desiccator and reweigh it. Repeat the process of heating, cooling and weighing until the difference between two consecutive readings does not exceed 2mg. Record the lowest weight. Loss in weight is calculated as the amount of moisture content present in it.

Calculations

Moisture content (percentage) =100(M1-M2)/ (M1-M)

Where,

M1=weight of dish with material before drying (grams)

M2=weigh of dish with dried material (grams)

M=weight of empty dish (grams)

Estimation of total dietary fibre content

About 2-5gm of moisture and fat free sample are weighed into a 500ml beaker and 200ml of boiling 0.255N(1.25% w/v) sulphuric acid is added. The mixture is boiled for 30 min keeping the volume constant by adding water at frequent intervals (glass rod inserted in the beaker helps in smooth boiling). At the end of this period the mixture is filtered through a muslin cloth and the residue is washed with hot water till free from acid. The material is then transferred to the same beaker and 200ml of boiling 0.313N (1.25% w/v) sodium hydroxide solution is added. After boiling for 30 min (keeping the volume constant as before). This mixture is filtered through a muslin cloth. The residue is washed with hot water till free from alkali, followed by washing with some alcohol and ether. Then it is transferred to a crucible, dried overnight at 80-100° C and weighed (We). The crucible is heated in muffle furnace at 600°C for 2-3 hrs, cooled and weighed again (Wa). The difference in the weights represents the weight of crude fibre.

Crude fiber (gm/100gm of sample) = [100-(moisture+fat)] [weight of fibre]/weight of the sample
Where weight of fibre = We-Wa

Estimation of Fat content
Procedure
Fat content is determined using Soxhlet extraction method. This is based on the continuous extraction of the food with a nonpolar organic solvent such as petroleum ether for about 16hrs. A known weight of food is placed in a porous thimble and the extracting solvent is poured in a dried weighed distillation flask. The solvent then mixes with the food, dissolves out the fat and eventually siphons back into the original distillation flask. The process is repeated continuously for a period of 16hrs, after which it is assumed that all the fat has been extracted from the food and is now present in the solution in the distillation flask. Removal of solvent leaves the fat as a residue. The flask is weighed and the increase in the weight of flask is taken as the weight of fat present in original food.
Here the dry sample 5-10gm is weighed accurately and placed in a thimble and plugged with cotton. Then thimble is placed in a Soxhlet apparatus and extract with anhydrous ether/petroleum ether for about 16hrs. The ether extracted is filtered into a weighed conical flask. The flask containing ether extract is washed 4-5 times with small quantities of ether and washings are also transferred. The ether is then removed by evaporation and the flask with the residue dried in an oven at 80-100ºC, then cooled in a desiccator and weighed.
Fat content (%) = (weight of ether extract) x100/weight of sample

Calculations

$$\%\text{Fat content} = \frac{\text{weight of fat extract} \times 100}{\text{Weight of sample taken}}$$

Estimation of protein content
The principle of method involves the estimation of total nitrogen content in food and conversion of nitrogen to protein assuming that all nitrogen in food is present as protein and using a conversion factor based on the percentage of nitrogen in food.
Conversion factor F=100/% of nitrogen

Procedure
A know weight of sample is digested with concentrated sulphuric acid and catalyst the amino group of amino acids and nitrogen present in the hetero cyclic rings of the histidine, proline, hydroxyl proline are converted to ammonia as well as carbon is oxidized as carbon dioxide. The ammonia is liberated from digester have been made alkaline is distilled and collected in standard dilute acid (0.1N H_2SO_4) and is estimated by titration using standard dilute alkali 0.1N NAOH.
Calculations:

$$\%\ N_2 = \frac{(\text{sample titre - blank}) \times \text{normality of HCL} \times 14 \times 100}{\text{Weight of sample} \times 100}$$

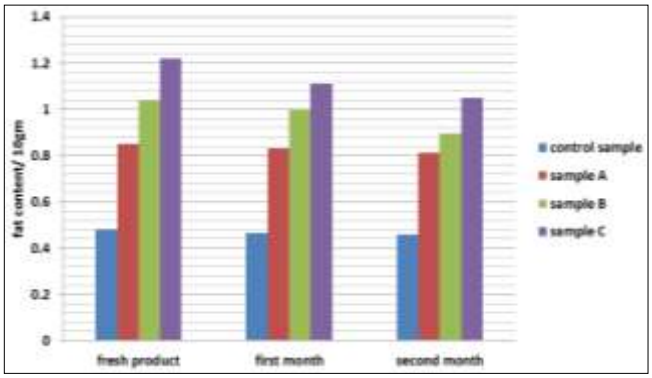
Determination of ash content
Procedure:
About 5gms of sample was weighed accurately in to a porcelain crucible. This is transferred into a muffle furnace set at 600°C and left for about 4hrs.About this time it had turned into white ash. The crucible and its content were cooled at room temperature in desiccator and weighed.
The percentage of ash calculated

$$\%\ \text{ash content} = \frac{\text{weight of ash}}{\text{Original weight of sample} \times 100}$$

Microbial count total plate count
The nutrient agar medium was taken and dissolved in distilled water according to the formulation requirement. The sample is prepared. Serial dilution and analysis of prepared samples are done under the sterilized conditions. Pour the agar solution in petri plates and wait until it solidifies. Then put the 1ml of sample on solidified agar solution. The petri plates were placed in inverted position and placed in incubator for 24hrs 370^0C. After 24hrs total plate count was calculated by using colony counter apparatus and results were noted.

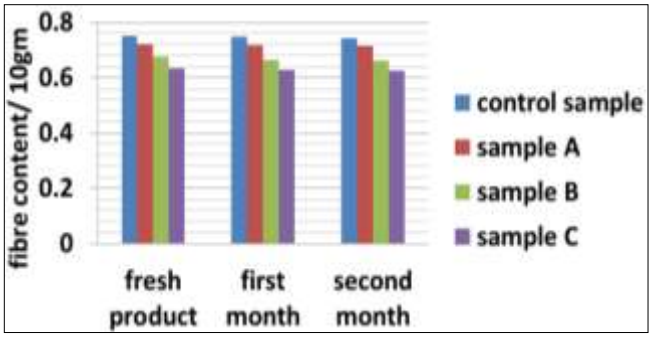
Sensory characteristics
Sensory characteristics of energy bar samples were evaluated for different sensory attributes by a group of nine panelists. Sensory attributes like appearance and color, texture, odour, flavor and taste and overall acceptability for all samples were assessed using nine point hedonic scale. Hedonic scale was in the following sequence: like extremely - 9, like very much - 8, like moderately −7, like slightly - 6, neither like nor dislike - 5, dislike slightly 4, dislike moderately, - 3, dislike very much - 2, dislike extremely – 1 (BIS 1971).

Results and Discussion
Fat and protein content of the energy bar increased gradually with increase in value addition i.e, with increase in the proportion of flaxseed and pumpkin seed mixture. Sample C has high fat and protein content comparatively to control sample, sample A and sample B. Mineral content is determined in terms of ash content. Mineral content of different samples increased with increase in value addition. Fibre content of different samples decreased with increase in value addition as the oats with high fibre content is replaced with flax and pumpkin seed mixture. Pumpkin seed has low fibre comparatively to flax seed and oats. Energy content of the samples increased with increased with increase in the mixture of flax seed and pumpkin seed. Incorporation the above flax and pumpkin seed powder as a premix in equal proportion in energy bar with 10%, 15%, and 20% as undergone sensory analysis and proximate analysis for about two months for the shelf life studies of the energy bars. The results revealed that the 15% of premix incorporated energy bars had the highest overall quality characteristics when compared to the other treatments combinations.



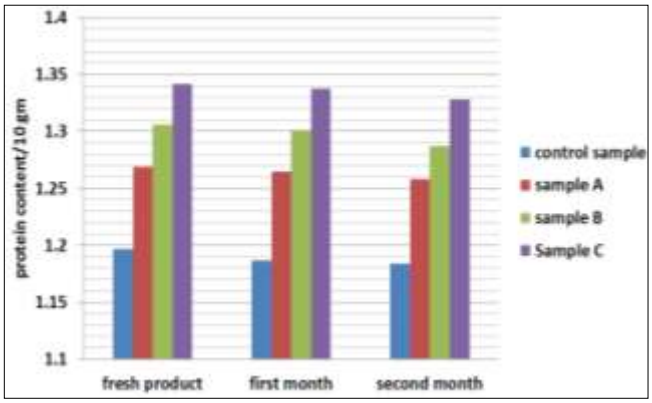
Graph 2: Change in fat content in different samples

Fat content of different samples i.e, control sample, sample a, sample B and sample C
Increased significantly for the fresh product and decreased with time period during shelf life studies. The results are observed in graphical representation.



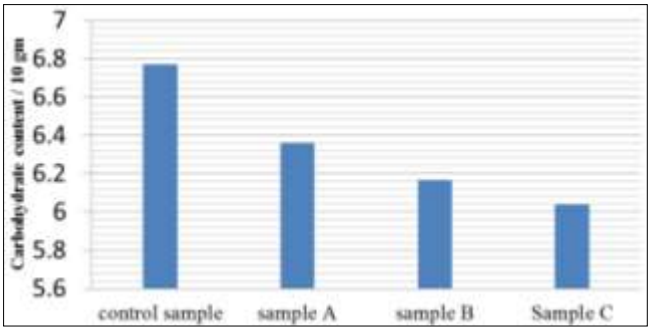
Graph 4: Change in fibre content in different samples

Fibre content of different samples i.e, control sample, sample A, sample B and sample C
Increased significantly for the fresh product and decreased with time period during shelf life studies. The results are observed in graphical representation.



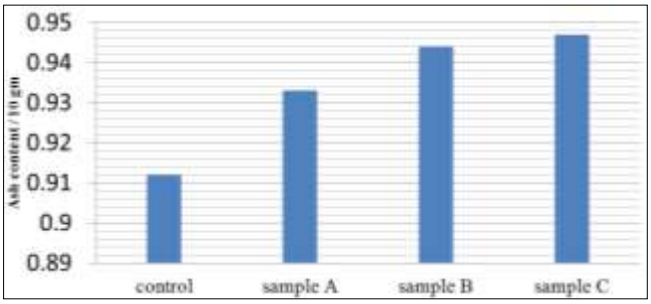
Graph 5: Change in Protein content in different samples

Protein content of different samples i.e, control sample, sample A, sample B and sample C
Increased significantly for the fresh product and decreased with time period during shelf life studies. The results are observed in graphical representation



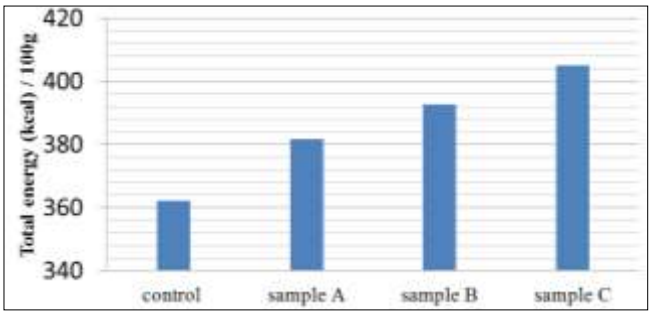
Graph 3: Change in Carbohydrate content in different samples

Carbohydrate content of different samples i.e, control sample, sample A, sample B and sample C increased significantly. The results are observed in graphical representation.



Graph 6: Change in Ash content in different samples

Mineral content is calculated for different samples in the form of ash content and results showed increase in ash content with value addition for different samples.



Graph 7: Total energy of different samples (kcal)

Energy value is calculated for different samples. Energy value of every sample increased with increase in value addition.

Table 10: Chemical analysis of flax seed powder per 100 gm

Nutrients	Chemical Value Per 100g
Energy(kcal)	530.29
Carbohydrate(g)	19.99
Fat(g)	41.17
Protein(g)	20.7
Fibre(g)	11.86
Ash content (%)	1.23
Moisture content (%)	5.05

Table 11: Chemical analysis of Pumpkin seed powder per 100 gm

Nutrients	Chemical Value Per 100g
Energy(kcal)	597.87
Carbohydrate(g)	14.33
Fat(g)	46.55
Protein(g)	28.4
Fibre(g)	3.87
Ash content (%)	1.32
Moisture content (%)	5.53

Table 12: Chemical analysis of Foxtail Millets powder per 100 gm

Nutrients	Chemical Value Per 100g
Energy(kcal)	371.6
Carbohydrate(g)	69.31
Fat(g)	5.24
Protein(g)	11.8
Fibre(g)	7.32
Ash content (%)	1.16
Moisture content (%)	4.17

Table 13: Nutritive value of energy bar per 100gm

Nutrients	Nutritive Value Per 100g			
	Control sample	Sample A	Sample B	Sample C
Energy(kcal)	362.11	381.71	392.7	404.08
Carbohydrate(g)	67.69	63.59	61.67	60.4
Fat(g)	4.83	8.51	10.42	12.20
Protein(g)	11.97	12.69	13.06	13.42
Fibre(g)	7.51	7.21	6.85	6.34
Minerals(g)	0.912	0.933	0.944	0.947

Conclusions

This study demonstrated that utilization flax seed, pumpkin seed, foxtail millet for the development of energy bar along with other nutritious ingredients showed that the bar is highly acceptable, easy to digest, contained high amount of energy along protein and omega 3 fatty acids with a shelf life of 60 days at room temperature. Flax seed is not only best source of omega 3 fatty acids but also good source of protein and fibre. Pumpkin seed is generally underutilized and considered as food waste but it is rich source of antioxidants and micronutrients. Foxtail millets is rich source of fibre and other nutrients. Keeping in view the importance of all the above seeds, they are used as ingredients in making of value added energy bar which are good source of nutrients.

Hence these energy bars are good for the people suffering from diabetes, cardiovascular diseases and obesity. Incorporation the above flax and pumpkin seed powder as a premix in equal proportion in energy bar with 10%, 15%, and 20% as undergone sensory analysis and proximate analysis for about two months for the shelf life studies of the energy bars. The results revealed that the 15% of premix incorporated energy bars had the highest overall quality characteristics when compared to the other treatments combinations. During the shelf life studies the protein and fat content in the energy bars are slightly decreased with time period. The development of energy bar using low cost, locally available ingredients is nutri dense and convenient breakfast snack.

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