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Development and quality evaluation of wafers incorporated with pearl millet flour and sorghum millet flour

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Abstract
Wafers incorporated with pearl millet flour and sorghum millet flour were developed and assessed for their nutritional & sensory parameters. Total ten formulations were prepared. First formulation prepared by incorporating 90 % refined wheat flour with 10 %, Pearl millet flour, Second formulation prepared 80% refined wheat flour with 20% pearl millet flour, third formulation prepared by 70% refined wheat flour, 30% pearl millet flour, fourth proportion prepared by 60% refined wheat flour, 40% pearl millet flour, fifth formulation prepared by 50% refined wheat flour, 50% pearl millet flour, sixth formulation prepared by 90% refined wheat flour, 10% sorghum millet flour, seventh formulation prepared by 80% refined wheat flour, 20% sorghum eight formulation prepared by 70% refined wheat flour, 30% sorghum millet flour ninth 60% refined wheat flour, 40% sorghum millet flour tenth formulation 50% sorghum millet and 50% refined wheat flour respectively and evaluated Organoleptical. A control was prepared with refined wheat flour and remaining all ingredients are same for all proportions. The quality assessment of plain-sheet supplemented with bajra and sorghum millet carried out in terms of nutrients such as moisture, fats, carbohydrates, ash, proteins, crude fiber, total sugars were also assessed. Sensory acceptability was assessed by 9- Point Hedonic Scale.

Keywords: refined wheat flour, wafers, pearl millet flour, sorghum millet flour, and baking quality

1. Introduction

1.1 Introduction to Wafers

The term ‘wafer’ usually refers to a thin crisp type of biscuit. The principal ingredient of wafers is wheat flour and the products undergo a process of heat treatment which reduces the moisture content of the products to a low level. Wafers and wafer products are generally regarded by the consumer as biscuits and they are frequently manufactured and sold by biscuit companies. Wafers consist essentially of a dried, highly aerated starch gel in which the starch granules have been completely gelatinized and dispersed.

Wafers offer a unique sensorial experience to consumers. Driven by consumer trends towards products which are lighter but still indulgent, the wafer category is expected to grow further. Wafers are seldom eaten alone and are often combined with components with a contrasting texture, such as chocolate or ice cream. Wafers are intermediate components used in the manufacture of several top selling confectionery products. The crispness and lightness contrasts well with soft cream or chocolate. The level of crispness and its retention over shelf life are critical parameters for the quality of wafer based confectionery products.

Wafers have been manufactured and marketed successfully for decades. During this time, minor additions/modifications have been made to suit local requirements. Much literature relates to bread or biscuit baking which has little relevance to wafer. The architecture of a flat wafer shows gas bubbles dispersed in a solid phase. The non-homogeneity of gas cell size, shape and distribution suggests that a wafer can be considered as ‘anisotropic foam’. The arrangement of solids and gas cells in solid foam such as a wafer determines its mechanical properties and can therefore influence sensory perception. In order to vary and control wafer texture, it is important to understand the science behind the structure formation during the baking process.

1.1.1 The Characteristics of Wafers

Wafers show precisely formed, smooth surfaces. These have details such as readings or logos grooved into the baking moulds. b. Wafers are of a delicate, crisp and light texture. The specific gravity of flat and hollow wafers is 0.2 g/cm3 or less. In the cross section you see a highly aerated matrix, primarily composed of gelatinized starch. c. The crispness of wafers is a result of the low residual moisture after baking, typically in the range of 1%–2%. The starch-protein matrix is in the glassy state. Wafers are quite hygroscopic and require high moisture barrier packaging. The crisp texture is lost at about 6%–7% moisture content. (Dogan, 2006).

1.1.2 The Two Basic Types of Wafers

i) No/low sugar wafers: Those contain zero to a few percent of sucrose or other sugars on a flour base. Typical products are flat and hollow wafer sheets and moulded wafer cones and cups—all of them baked in closed moulds under pressure with substantial steam leavening. With sheet wafer processing after baking, the wafer typically is sandwiched to form wafer biscuits with sweet fillings, and the wafer biscuit may then be enrobed with chocolate.

ii) Sugar wafers: More than 10% of sugars on a flour base result in some plasticity of the freshly baked hot wafers. At even higher sugar percentages, the wafers are formed into different shapes by rolling, pressing or deep forming; this is possible before the sugar re-solidifies during the col down.

For both types of wafers, the main ingredient is wheat flour. That fits very well into current dietary recommendations to consume more cereals. Moreover, wafer products with a partial replacement of wheat flour and gluten-free wafers are increasingly available in the market.

1.2 Introduction to Millets

Millets are nutritionally rich and occupy an important place in the diet of people in many regions of the world. Although millets are nutritionally superior to cereals their utilization as a food is still mostly confined to traditional consumers and population of lower economics data (Jaybhaye, Pardeshi-2014)

Millets are considered as crop of food security because of their sustainability in adverse agro climatic conditions (Ushakumari *et al*., 2004). These crops have substantive potential in broadening the genetic diversity in the food basket and ensuring improved food and nutrition security (Mal *et al*., 2010). Along with nutrition millets offer health benefits in daily diet and help in the management of disorders like diabetes mellitus, obesity, hyperlipidemia, etc. (Veena, 2003). Millets offer unique advantage for health being rich in micronutrients, particularly minerals and B vitamins as well as nutraceuticals. Though millets are not the important part of daily diet of American and European people, now these countries have recognized the importance of millets as ingredient in multigrain and gluten-free cereal products. However, in many Asian and African countries millet is the staple food of the people in millet producing areas and used to prepare various traditional foods and beverages like idle, dose, papad, chakli, porridges, breads, infant and snack foods (Chandrasekhar and Shahidi, 2011) [6]. Whilst a number of traditional foods are made in the domestic household, the lack of largescale industrial utilization discourages the farmers raising millet crops (Subramanian and Viswanathan, 2003)

1.2.1 Pearl Millet (Pennisetumglaucum)

Pearl mill*et al*so known as bajra is one of the important millet grown in tropical and semiarid region of the world. The amino acid composition has significant effect on the nutritional quality of protein. It has high energy, less starch, low GI and is gluten free. Pearl millet with regard to nutritional quality is equivalent to maize and generally superior to sorghum in protein content/quality and metabolizable energy levels (Agte *et al*., 1999), as well as digestibility (Ejeta *et al*., 1987). Tannins commonly found in other staple crops such as sorghum, which can decrease digestibility (Dykes and Rooney, 2006) usually absent which contain significant amounts of condensed polyphenols. Pearl millet is also rich in important micronutrients such as Fe and Zn, and has a more complete amino acid profile than maize or sorghum (Ejeta *et al*., 1987). Taken in totality, these qualities make pearl millet a major contributor of dietary protein, Fe, and Zn intake in a variety of rural populations in India (Kodkany *et al*., 2013).

1.2.2 Sorghum

Sorghum (Sorghum bicolor (L.) Moench) is a warm season crop, intolerant of low temperatures but fairly resistant to serious pests and diseases. It is known by a variety of names (such as great millet and guinea corn in West Africa, Asia and parts of Middle East). Most of the sorghum produced in North and Central America, South America and Oceania is used for animal feed (FAO, 1995). The grain consists of naked caryopsis, made up of a pericarp, endosperm and germ. Although there is a huge range of physical diversity, sorghum are classed into four groups: (1) grain sorghum, (2) forage sorghum glum; (3) grass sorghum; or (4) Sudan sorghums and broomcorn (Macrae*et al*., 1993)

The main aim of the study to develop nutritional rich wafer and asses the nutritive and sensory analysis of developed wafers.

2. Materials and Methods

2.1 Materials required

1. Refined Wheat flour (Maida) procured from the local market
2. Pearl millet flour procured from the local market
3. sorghum millet flour procured from local market
4. sugar procured from the local market
5. sunflower oil procured from the local market
6. Salt, baking soda which were procured from the local market

2.2 Method of Processing of wafers (Control)

Mixing of all ingredients for 6 mins (Maida, salt, sugar, sunflower oil, water, baking soda)

↓

Baking in oven (200ºC, 5 mins)

↓

Sheeting

↓

Cooling (2 mins)

↓

Packing & storage

Fig 2: Flow Chart for processing of Wafers (Control sample)

2.2.1 Mixing of Batter

Mixing of all the raw materials together for 2.5–6 minutes to achieve homogeneity. Usage of high shear mixers is best suited for the purpose because slower mixers may allow gluten strand formation. This results into strings and lumps in the mixed batter. The mixing process should proceed as soon as possible after the assembly of all the ingredients. This reduces the possibility of a ‘dough’ formation between flour and water. The use of cold water also reduces the tendency for gluten string formation. Immediately after mixing, the batter has much air incorporated and may be slightly lumpy due to incomplete mixing. As the air rises out of the mix the viscosity reduces. A screen helps in removal of lumps and gluten strands and a constant gentle agitation to prevent separation in the batter.

2.2.2 Baking

The baking process involves the usage of Wafer Ovens. Ovens are made up of heated metal plates hinged at one side, typically thin and usually bear intricate surface patterns. The plates either attached to heavy carriers or are self-supporting linked together to form a chain. Heating of plates is done through direct impingement of gas flames or individually by electric heaters arranged in the backs of the plate. The batter is deposited, usually in the lower plate, and on closing and locking with the upper plate. The very rapid production of steam not only spreads the batter evenly throughout the gap between the plates but also to a certain extent out through the vents. A minimum extrusion through all the vents is the aim as because that portion is valueless. The thickness of the wafers is proportional to the gap between the two plates.

2.2.3 Cooling

Convection air cooling at 10-12ºC. The humidity of the air should be kept as low as possible because by cooling the RH rises and this promotes moisture pick-up by the exposed wafers. The cooled wafer books should not leave the cooler with a surface temperature below the local dew point otherwise moisture will be picked up on the exposed wafers and warping leading to splitting apart of wafers from cream may occur.

2.2.4 Cutting

The cooled books are cut into eating size squares, rectangles, fingers, etc. This is done by pushing them singly or in small piles through sets of taut wires, blades or circular saws.

Formulations

Table 3: Ingredients for plane wafer biscuits

Raw Materials	Control	A	B	C	D	E	F	G	H	I	J
Maida(g)	100	90	80	70	60	50	90	80	70	60	50
Pearl millet flour(g)	-	10	20	30	40	50	-	-	-	-	-
Sorghum flour(g)	-	-	-	-	-	-	10	20	30	40	50
Water(ml)	170	170	170	170	170	170	170	170	170	170	170
Salt (g)	1	1	1	1	1	1	1	1	1	1	1
Sugar(g)	5	5	5	5	5	5	5	5	5	5	5
Baking soda(g)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Oil(ml)	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3

2.3 Methods

2.3.1 Determination of moisture content

Apparatus

a. Petri plate dishes.
b. Hot air oven.
c. Weighing balance.
d. Desiccator containing efficient desiccant such as phosphorus pentoxide or calcium chloride.

Procedure

Weigh accurately about 5 grams of sample in a previously dried and tare moisture dish. Place the dish in the hot air oven maintained at 105oC temperature and dry at least for 2 hours. Cool in a desiccator and weigh. Repeat the process of heating, cooling, and weighing until the difference between the two consecutive readings doesn't exceed 2mg. Record the lowest weight.

$$\text{Moisture (\%)} = \frac{w2 - w1 - (w3 - w2)}{(w2 - w1)}$$

Where,
W1 = Initial weight of petri dish (g)
W2 = Weight of the petri dish with sample before drying (g)
W3 = Weight of the petri dish with sample after drying (g).

2.3.2 Determination of ash value

Apparatus

Muffle Furnace
Crucibles
Desiccators: containing an efficient desiccant for example freshly dried silica gel

Procedure

The ash value is mainly due to potassium and phosphorous and the composition of it. About five grams of the sample were weighed accurately into a porcelain crucible. This was transferred into A muffle furnace set at 600°C and left for about 4 hours. About this time it had turned into white Ash. The crucible and its content were cooled to about 100°C in the air, then to room temperature In desiccators and weighed. The percentage ash was calculated from the formula below.
% Ash content = (weight of Ash/Original weight of sample) x100

2.3.3 Determination of crude fiber

Reagents

- Sulfuric acid (H_2SO4) 1.25% - 0.255 ± 0.005 N. 12, 5g, 98% concentrated to 1000 ml
- With distilled water. Control the concentration by titration.
- Potassium hydroxide (KOH) 1.25% - 0.223 ± 0.005 N, free from carbonate. 12.5 g to
- 1000 ml with distilled water. Control the concentration by titration.
- N-octanol as antifoam.
- Anhydrous acetone

Procedure

Determine separately the sample moisture by heating in an oven at 105°C to constant weight.
Cool in a desiccator. Weight accurately about 1 g of grinded sample (1 mm about) approximately with 1 mg. ==> W1. Add 1.25% sulfuric acid up to the 150 ml notch, after preheating by the hot plate in order to reduce the time required for boiling. Add 3-5 drops of n-octanol as antifoam agent. Boil 30 minutes exactly from the onset of boiling. Connect to vacuum for draining sulfuric acid. Wash three times with 30 ml (crucible filled up to the top) of hot deionized water, connecting each time to compressed air for stirring the content of crucible.

2.3.4 Determination of protein

Kjeldahl method

A food is digested with a strong acid so that it releases nitrogen which can be determined by a Suitable titration technique. The amount of protein present is then calculated from the nitrogen concentration of the food. The Kjeldahl method does not measure the protein content directly a conversion factor (F) is needed to convert the measured nitrogen concentration to a protein concentration. A conversion factor of 6.25 (equivalent to 0.16 g nitrogen per gram of protein) is used for many applications, however, this is only an average value, and each protein has a different conversion factor depending on its amino-acid composition.

Procedure

Take 0.55g of sample in a digestion tube of instrument & add 25ml concentrated H_2SO_4 and 1-2 Catalyst stabilizers. Adjust temperature to 370°C and keep for digestion for 4-6 hours till the solution becomes blue in color. Remove the tube from 0.1N H_2SO_4 solution in a titration flask, placing of the distillation unit, attach a tube containing digested sample to distillation until the press start button to effect a metered addition of NaOH & to initiate steam distillation stops add 5 drops to yellow color. This is the end point. Now using 25ml of 0.1N HCl with 0.1N NaOH in the burette. Once the nitrogen content has been determined it is converted to a protein content using the appropriate conversion factor: %Protein = 6.23 X %N.

$$\text{Protein} = \frac{\text{blank sample X Normality X 1.4007X 6.25}}{\text{Weight of Sample}}$$

2.3.5 Determination of fat
Reagents: Hexane

Procedure
Fat was estimated by soxhlet method. Take an empty thimble (container) weight. Weigh 5 grams of sample into a dry thimble. Difference in weight gives sample weight. Weight the empty soxtherm flask with boiling stone. Keep the thimble in soxtherm extractor. Pour the solvent (150 ml of hexane) into the soxtherm flask. Fix the soxtherm flask in soxtherm extraction apparatus with a reflux condenser. Keep the total arrangement of process for at least 4 hours. After 4 hours, take out the solvent from hexane and thimble from extraction apparatus. Keep the soxhlet flask in the hot air oven for 10 minutes to evaporate the solvent and cool it in a desiccator. Then weigh the flask with extracted fat.

Calculation

$$\% \text{ Fat content} = 100 \times (W3–W2) / (W1–W)$$

Where,
W - Weight in grams of empty thimble
W1 - Weight in grams of thimble with sample
W2 - Weight in grams of empty soxtherm flask
W3 - Weight in grams of soxtherm flask with extracted fat

2.3.6 Determination of carbohydrates

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

2.3.7 Determination of calcium
Take 2ml of mineral solution into a 15ml centrifugal tube. Add 2ml of distilled water and 1ml of 4% ammonium oxalate solution and mix thoroughly and leave overnight. Again the contents are mixed and centrifuged for 5min at 1500rpm. The supernatant liquid is poured off and the centrifuge tube is drained by inverting the tube for 5min on a rack (care should be taken not to disturb the precipitate). The mouth of centrifuge tube is wiped with a piece of filter paper. The precipitate is stirred and the sides of the tubes are washed with 3ml dilute ammonia. It is centrifuged again and drained as before. The precipitate is washed once more with dilute ammonia to ensure complete removal of ammonium oxalate. The precipitate is dissolved in 2ml of 1N H_2SO_4.
Blank: Take 2ml of 1N H2SO4 heat and titrate against KMnO4 solution till pink color is obtained.
Formulae: 1ml of 0.01N KMnO4 is equivalent to 0.2004 mf of Ca.
Calcium content was calculated as follows:

$$\text{Calcium} = \frac{\text{Titre value x N of KMnO 4 x 20 x Total vol .of ash sol}}{\text{ml of ash solution wt of sample taken for estimation}} \text{ x100}$$

2.4 Sensory Evaluation
All dried noodle samples were prepared for sensory evaluation. The samples were boiled using Water for the optimum cooking time. Cooked noodles with masala mix were evaluated for appearance, flavor, taste, texture and overall acceptability of the samples by 10 untrained panelists using nine-point hedonic scales, where 9 = extremely like and 1 = extremely dislike.
The optimal ratio of tamarind kernel flour in the noodles was investigated using sensory qualities in comparison to the control pasta.

Feeling/Attribute	Rating
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

3. Results and discussions

Table 1: Proximate Analysis of constituents for various wafers formulations

s/no	Sample	Moisture (%)	Ash (%)	Acid insoluble ash (%)	Protein (gm)	Fat (gm)	Crude fiber (gm)	CHO (gm)	Eng (Kcal)	Ca (mg)	Ph (mg)	Fe (mg)
1	Control	1.5	0.6	0.065	11	2.2	2.1	79.81	386	36.1	164.61	2.94
2	A	1.9	0.81	0.085	11.63	2.61	2.4	79.17	388	38	182.11	3.47
3	B	2.01	0.9	0.089	11.72	3.02	2.82	78.53	389.3	39.9	199.11	4
4	C	2.2	1.2	0.090	11.84	3.43	3.18	77.56	390.6	41.8	217.11	4.53
5	D	2.4	1.32	0.092	11.91	3.84	3.54	77.22	391.6	43.8	234.61	5.06
6	E	2.5	1.6	0.095	12.01	4.25	3.9	76.61	393.2	45.6	252.51	5.59
7	F	1.8	1.1	0.080	11.65	2.3	2.27	79.68	386.3	36.3	174.71	3.08
8	G	1.9	1.2	0.082	11.59	2.4	2.39	79.55	387.2	36.5	184.81	3.22
9	H	2.1	1.35	0.086	11.53	2.5	2.53	79.42	387.6	36.7	194.91	3.31
10	I	2.2	1.42	0.089	11.47	2.6	2.66	79.29	388.2	36.8	205	3.5
11	J	2.3	1.51	0.092	11.41	2.7	2.79	79.16	388.8	37.1	215.1	4.24

3.1.1 Moisture

Even though Wafers from all the formulations were subjected to a constant drying time of 4.5 hr in hot air oven there was very slight difference in the moisture contents of the formulations .It could be due to the difference in the quantity of water used for batter making which again is influenced by increasing proportions of pearl millet flour and Sorghum millet flour. Moisture Content was highest in sample F (90% Refined wheat flour+10%sorghum flour) as displayed in fig.2

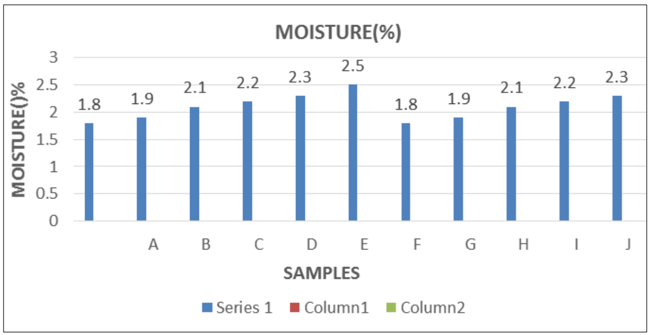

Fig 2

3.1.2 Ash

The mineral content was found to be highest (1.6 %) in sample E followed by sample J. It could be due to increased percentage of pearl millet and sorghum millet flour as seen in fig.3

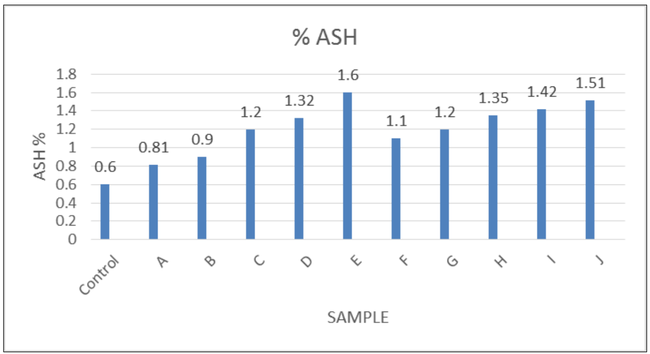

Fig 3

3.1.3 Acid Insoluble Ash

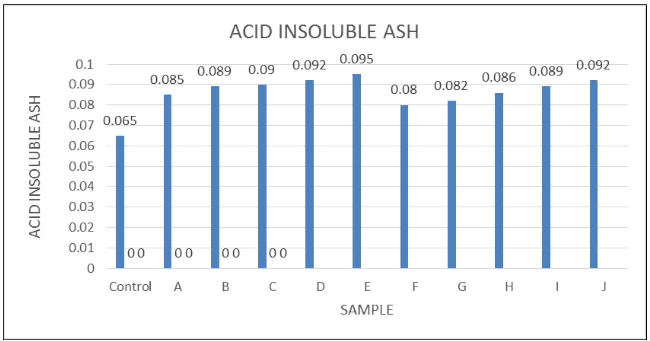

Fig 4

3.1.4 Protein

The protein content is contributed by wheat flour, millets. The protein content was highest (12 %) in sample E due to increased pearl millet flour as shown in fig 5.

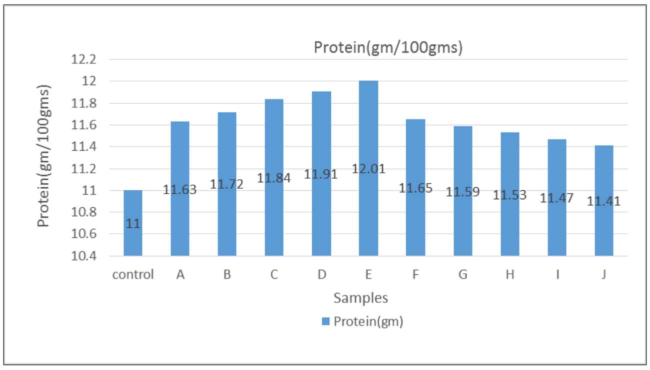

Fig 5

3.1.5 Fat

The fat content was highest (4.2%) in sample E (50% Refined wheat flour+50%Peral millet flour.) as shown in fig 6.

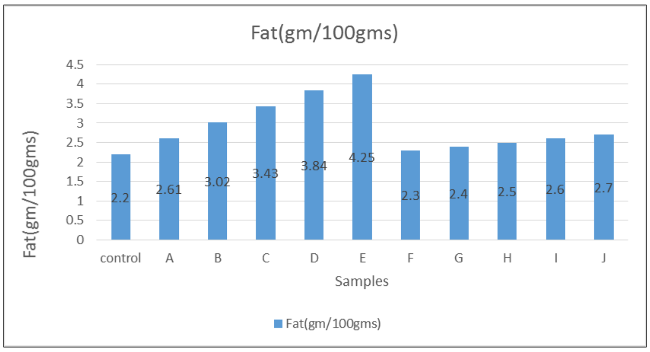

Fig 6

3.1.6 Crude fiber

Fiber content increased in all the supplemented samples compared to control (T) due to sorghum flour and pearl millet flour. Crude fiber content is highest (3.9%) in the formulation E with 50 % pearl millet flour + 50 % Refined wheat flour. followed by formulation as shown in fig.6

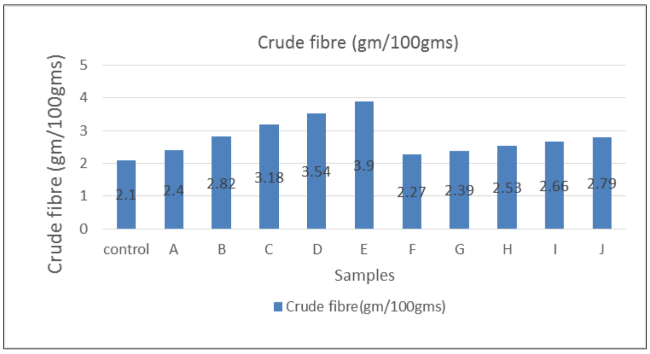

Fig 8

3.1.7 Carbohydrate

The carbohydrate content was found to be decreased in the samples. It could be due to the increased content of the pearl millet flour and Sorghum millet flour in formulation. As shown in fig 8.

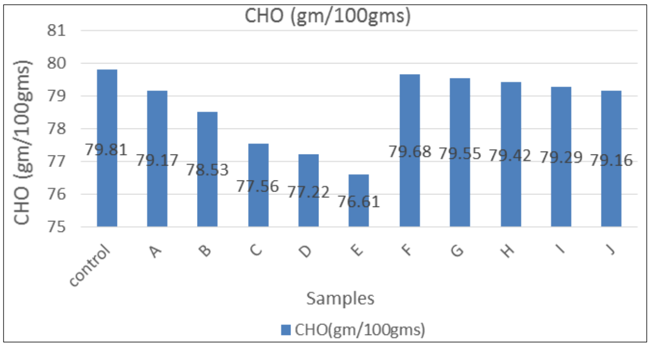

Fig 9

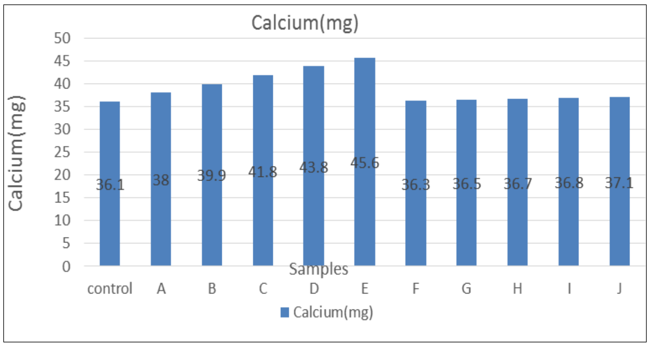

Fig 10

3.1.8 Calcium

The calcium content is high in the sample E (50%refined wheat flour +50% pearl millet flour). It could be due to the increased content of pearl millet flour. The results shown in the fig 9.

4. Sensory Evaluation of wafers incorporated with pearl millet flour and Sorghum millet flour.

The ten formulations were subjected to sensory evaluation. The sensory scores suggested for formulations revealed C, D, H, I were had maximum acceptability as shown in table

Table 2: Sensory score of incorporated formulations

Samples	Color	Appearance	Taste	Texture	Flavor	Over all acceptability
Control	7.2±0.9944	7.5±0.9884	6.9±0.5612	7.0±0.6324	7.1±0.3821	7.2±0.7117
A	6.5±0.1452	6.3±0.5621	6.6±0.4389	6.0±0.2745	7.5±0.5813	6.9±0.9014
B	6.4±0.3264	6.2±0.5378	6.9±0.2916	7.1±0.6513	6.3±0.6941	6.8±0.5391
C	7.7±0.5678	7.3±1.6723	7.1±0.2764	7.9±0.5932	7.1±0.8209	7.4±0.9413
D	7.4±0.5612	7.2±1.8932	7.0±0.5201	7.9±0.9745	7.2±0.8284	7.3±0.7554
E	7.4±0.3264	7.2±0.5378	6.9±0.2916	7.1±0.6513	6.3±0.6941	6.9±0.5391
F	6.2±0.1232	6.1±0.4341	6.5±0.4329	6.0±0.2745	7.3±0.4516	6.4±0.3432
G	6.1±0.6739	6.9±0.9012	7.2±0.4247	6.4±0.9503	6.2±0.0472	6.5±0.5994
H	7.5±0.9944	7.8±0.7888	6.5±0.5163	7.0±0.6234	7.1±0.2881	7.3±0.6992
I	7.7±0.5678	7.5±1.673	7.8±0.2764	7.9±0.5932	7.1±0.8209	7.6±0.5861
J	6.8±0.3243	7.0±0.4125	6.9±0.1321	6.5±0.2578	6.9±0.1321	6.8±0.2517

Control; 100% refined wheat flour.
A: 90% Refined wheat flour +10 % Pearl millet flour.
B: 80% Refined wheat flour+20% Pearl millet flour.
C: 70 % Refined wheat flour +30% Pearl millet flour.
D: 60% Refined wheat flour+40% Pearl millet flour.
E: 50 % Refined wheat flour+50% Pearl millet flour.
F: 90% Refined wheat flour+10% Sorghum millet flour.
G: 80% Refined wheat flour+20% Sorghum millet flour.
H: 70%Refined wheat flour+30% Sorghum millet flour.
I: 60% Refined wheat flour +40%Sorghum millet flour.
J: 50% refined wheat flour +50% Sorghum millet flour.

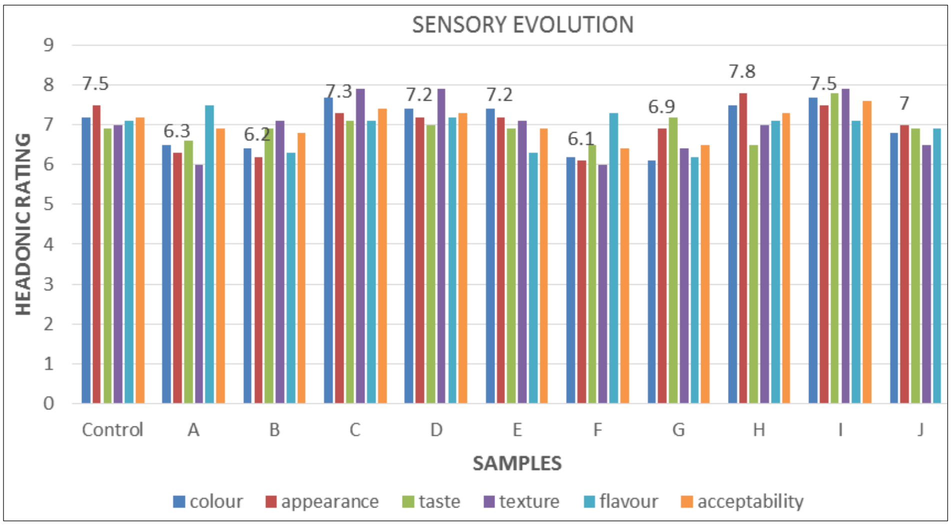

Fig 11

5. Conclusion

Wafers are our everyday foods, as crisp low fat food products made of wheat flour. Wafers can be made more nutritious by incorporating with millets like pearl millet and sorghum millet. Pearl Millet is high in proteins, calcium, folic acid and fat. The highest protein content was observed for the formulation with 50 % refined wheat flour, 50 % pearl millet flour (E) and fat, carbohydrates is highest in the formulation with 90% refined wheat flour, 10 % pearl millet flour (A).Highest ash content was observed for the formulation with 50 % refined wheat flour, 50%Pearl millet flour (E).Highest crude fiber was observed for the formulation

50% refined wheat flour, 50% Pearl millet flour (E). Sensory scores were highest for the formulations with 70 %refined wheat flour,30 % pearl millet flour(C), 60%Refined wheat flour, 40% Pearl millet flour(D), 70%Refined wheat flour, 30% Sorghum millet flour (H), 60%Refined wheat flour, 40% Sorghum millet flour (I) these samples most acceptable formulations. Nutritionally and organoleptic ally (Taste) the above stated formulations were superior but their visual appearance was negatively affected due to darker color compared to the control.

6. References

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