Development and Sensory Evaluation of Industrial High Energy Fortified Biscuits before Implementation of Food Safety

A.A. Siddiqui, M. A. Alim

Abstract- The present study was conducted to prepare the high energy fortified biscuits as influenced by different levels of soy flour protein and wheat flour gluten content of the biscuit recipes in a food industry before food safety implementation. Packaging study was also conducted by high density polyethylene up to 90 days of storage showing moisture content just above Bangladesh Standards and Testing Institute (BSTI) requirement at 90 days for the samples S1, S2 and S3. Moisture%, Protein %, fat %, sucrose % and iron content remained acceptable considering BSTI requirements. Sample S1 containing highest soy flour protein and wheat flour gluten estimated highest protein %, fat% and iron content compared to sample S2 and S3. Microbial qualities of biscuits found acceptable at initial storage regardless of microbial quality of raw materials. Sensory qualities of biscuits were also evaluated which showed the sample S3 , treated with lowest amount of soy flour protein and wheat flour gluten, was the most preferred biscuit with respect to all the quality attributes. Though the high energy fortified biscuit has compact source of energy, packaging condition was not sufficient to hold moisture content as BSTI standard level during 90 days of storage. Sensory evaluation suggested optimum level of soy flour fortification.

Key Words: Energy, soy flour, wheat flour, protein, gluten, BSTI, moisture.

1 INTRODUCTION:

Bakery biscuits are ready to eat, convenient and inexpensive food products containing digestive and dietary principles of vital importance. These biscuits become popular both in rural and urban population in Bangladesh. These baked products have about 10-15% proteins.

Biscuits owing to their long shelf life are considered useful for nutritional enrichment in feeding programs [1]. In recent years, consumption of biscuits has increased in most of countries as they served as important source of nutrients[11], Soy flour has a great potential due to its high and good quality proteins(35 to 45%), Vitamins (Vitamin B- complex) and minerals, which can be used for fortification in baked products like bread, biscuits etc. The study was undertaken to see the quality of biscuits in an Industry before implementation of Food Safety program.

Inappropriate management of food production operations can cause several problems on quality aspects like food safety, customer satisfaction, and availability. For example, inappropriate temperature control of confectionery containing e.g. cream, fresh fruit and meat causes growth of microorganisms, which can result in safety problems, product failures, and customer complaints. Inappropriate planning of production and distribution causes either overproduction resulting in loss of materials or unavailability of products, which require additional production and deliveries leading to customer complaints and failure costs.

2 MATERIALS AND METHOD:

2.1 Materials:

Productions of high energy fortified biscuits were prepared from soy flour. This powder was used for fortification in biscuits. The approximate composition of the dough of the fortified biscuits had the following basic ingredients (dry weight basis):

1. Wheat flour: 69% by weight

- *A.A.Siddiqui is a professor in the Dept. of Food Engineering & Technology, State University of Bangladesh, Bangladesh, PH-+8801715164951. E-mail: siddiqui_anis@yahoo..com*
- *M.A.Alim is a professor in the Dept. of Food Technology & Rural Industries, Bangladesh Agricultural University, Mymensingh, Bangladesh, PH-+8801732252229. E-mail: maalim07@yahoo.com*

2. Sugar: 12% by weight

3. Vegetable fat (food grade, hydrogenated-75 & liquid-25%) : 13%

4. Soya Flour (full fat, from food grade Shohag variety) : 6%

The following baking materials and premix were to be added to the basic ingredients:

5. Iodized salt (food grade) : 0.5%

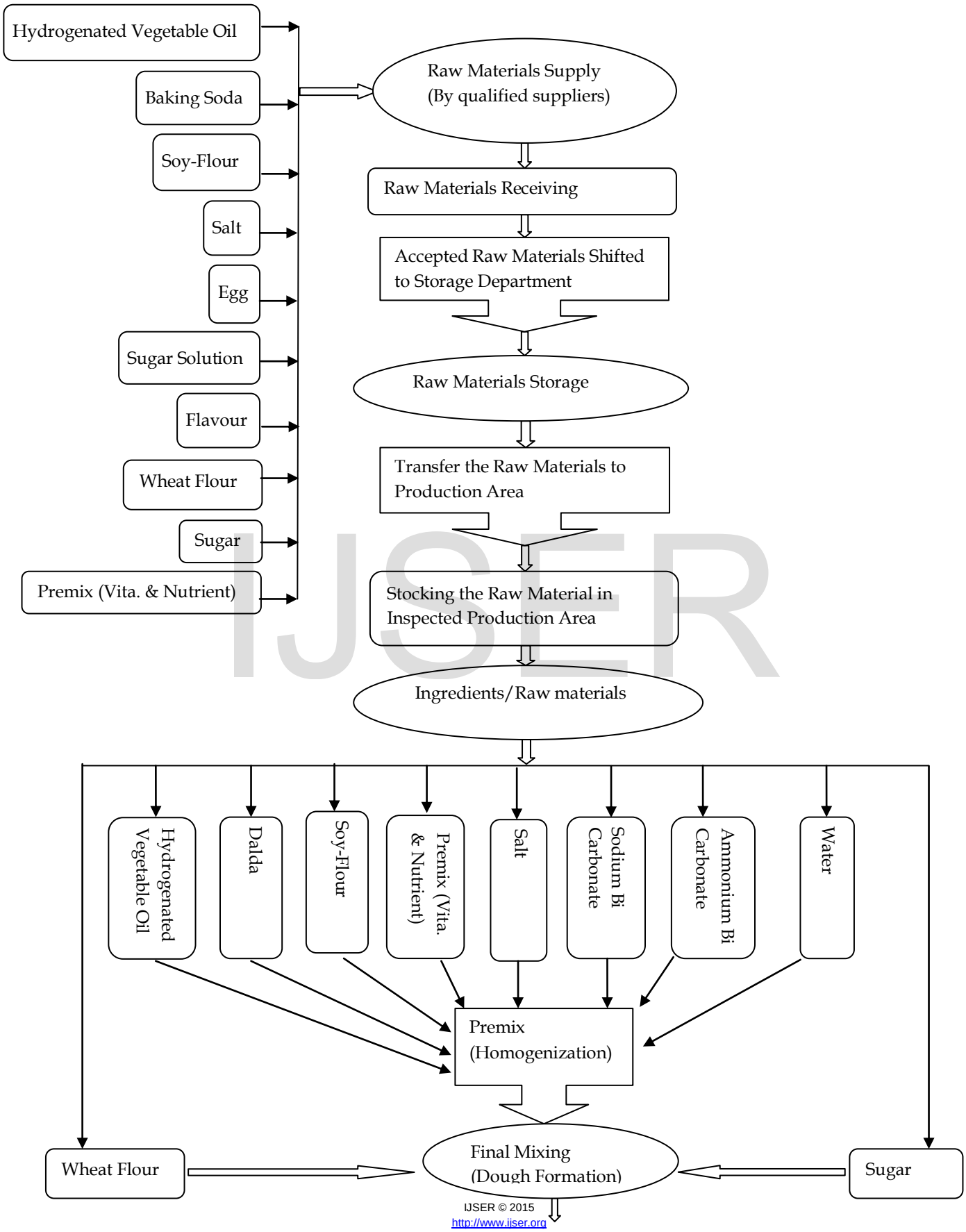
6. Leavening agent (baking soda + ammonium bicarbonate) not exceeding 1.0%

7. Micronutrient premix: 1.5 kg premix in 998.5 kg biscuit dough (dry weight).

2.2 Methods:

Water, ammonium bicarbonate, sodium bicarbonate, salt, vitamin & nutrient premix, soy flour, dalda and hydrogenated vegetable oil mixed initially by homogenization as premix. Final dough formation was done by final mixing with premix, wheat flour and sugar. After moulding and cutting, biscuit shape was formed. Baking was done with 200 – 350 0C for 6 to 10 minutes. Cooling was done in room temperature. The biscuits were packed in high density polyethylene bags using as primary packaging and stored under ambient conditions (21-300C and 62-85% RH) with packaging materials.

Biscuit from wheat and soy flour composite will be acceptable in terms of colour, aroma and overall acceptability [7].


Hydrogenated Vegetable Oil
Baking Soda
Soy-Flour
Salt
Egg
Sugar Solution
Flavour
Wheat Flour
Sugar
Premix (Vita. & Nutrient)
Raw Materials Supply (By qualified suppliers)
Raw Materials Receiving
Accepted Raw Materials Shifted to Storage Department
Raw Materials Storage
Transfer the Raw Materials to Production Area
Stocking the Raw Material in Inspected Production Area
Ingredients/Raw materials
Hydrogenated Vegetable Oil
Dalda
Soy-Flour
Premix (Vita. & Nutrient)
Salt
Sodium Bi Carbonate
Ammonium Bi Carbonate
Water
Premix (Homogenization)
Wheat Flour
Final Mixing (Dough Formation)
Sugar

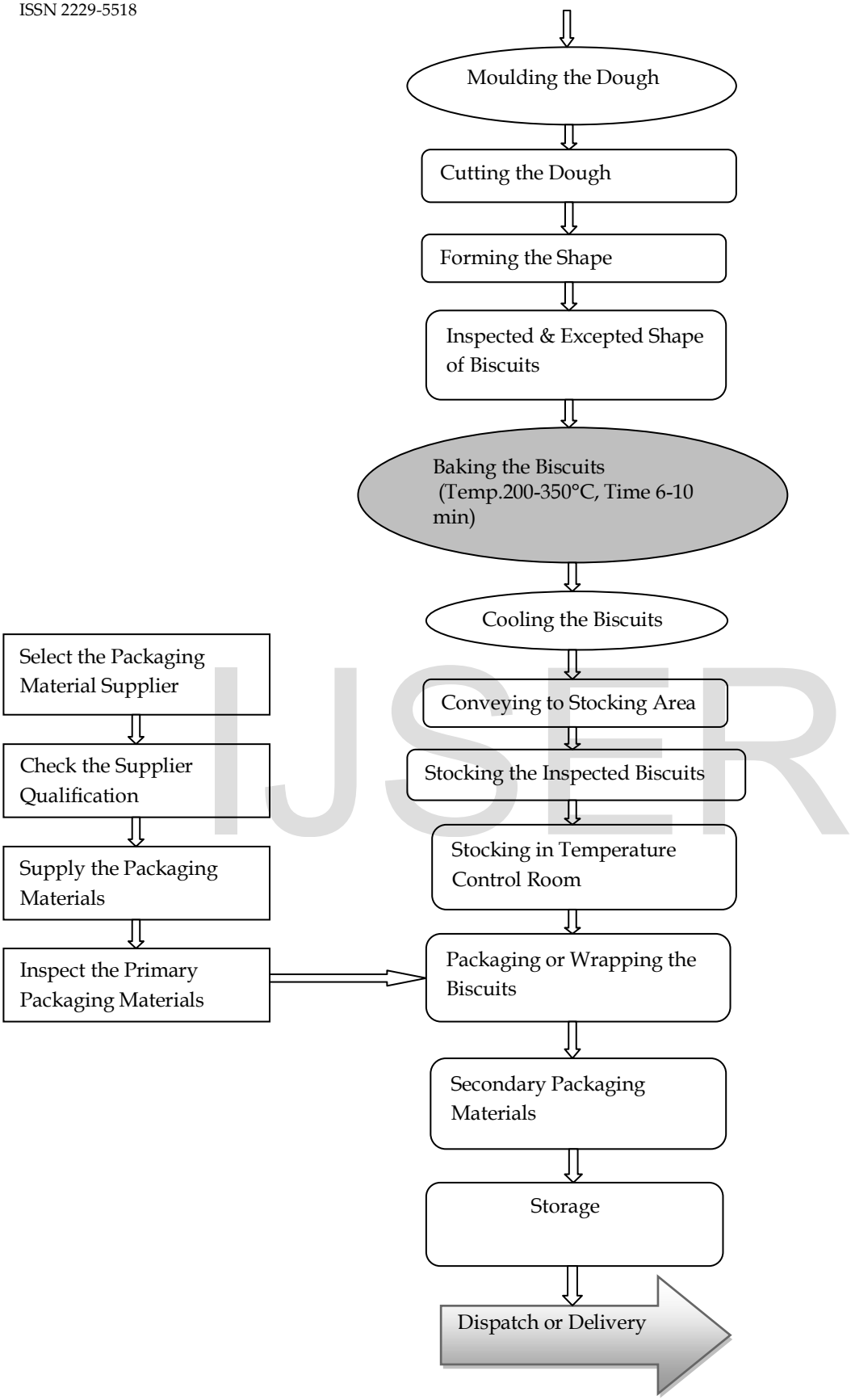


fig1. Flow diagram of fortified high energy biscuit.

2.3 Sample Recipes:

Wheat and Soy flour was collected from ten local suppliers with coded name A to J and was analyzed for wheat flour gluten %, soy flour protein % and moisture %. Three coded samples were selected on the basis of maximum wheat flour gluten and soy flour protein contents. Those coded samples were used for making three sample recipes S1, S2 and S3. Total Viable Count, Enterobacteriaceae (Total Coliform), Escherichia coli, Salmonella spp. and Yeast and mold count of wheat flour were also determined according to the "Recommended method for the Microbiological Examination of Food", Published by American Public Health association [2].

2.4 Wet Gluten Determination:

This method was based on the Glutomatic Gluten Washer and Gluten Index Centrifuge and provides information on both quantity and quality of wet gluten. Wet gluten in wheat flour is a plastic-elastic substance consisting of the proteins gliadin and glutenin, obtained after washing out the starch from wheat flour dough. Gluten separated from whole wheat meal or wheat flour by the Glutomatic was centrifuged to force wet gluten through a specially constructed sieve undern standardised conditions. The special sieve allowed for the collection of both the part of the gluten that remained on the sieve and the part which passed through the sieve. The total weight of the gluten was defined as gluten quantity. The percentage of wet gluten remaining on the sieve after centrifugation was defined as the Gluten Index. If the gluten was very weak all of the gluten might pass through the sieve, the Gluten Index was 0. When nothing passed through the sieve, the Index was 100.

Moisture content was determined adopting [2] method.

Protein content of samples was determined by using Kjeldahl method [10].

2.5 Proximate composition of raw material developed products

The samples were analyzed for moisture, protein, fat, sugar (as sucrose) and iron content using the following standard methods.

Moisture: Moisture content was determined adopting [2] method.

Protein: Protein content of sample was determined by using Kjeldahl method [10].

Fat: Fat content of sample was determined by using Soxhlet apparatus method [10].

Sucrose (as Non-reducing sugar): Sucrose content was determined using [10].

Iron content was determined by Spectrophotometer. Beckman model 24 was used for iron determination.

2.6 Chemical Changes:

The withdrawals of the samples were done at 45 days intervals for chemical analysis up to 90 days. The samples S1, S2 and S3 packed in thick packaging material containing LDPE: LLDPE 40 μ. Chemical changes such as moisture, protein, fat; sugar (as sucrose) and iron content were observed at the storage periods.

2.7 Microbiological Study:

Total Viable Count, Enterobacteriaceae (Total Coliform), Escherichia coli, Salmonella spp. and Yeast and mold count of the biscuit samples were also determined according to the "Recommended method for the Microbiological Examination of Food", Published by American Public Health association [2].

2.8 Statistical Analysis:

All biscuit sample data were analyzed statistically. ANOVA was used for determining significance / non significance data. SPSS 11.5 version was used to analyze the data.

2.9 Subjective (sensory) evaluation of Biscuits:

For statistical analysis of sensory data, different samples were evaluated for colour, flavour, texture and overall acceptability by a panel of 11 testers. All the testers were briefed before evaluation. The samples were presented to 11 panelists and randomly coded sample. The test panelists were asked to rate the different composition presented to them on a 9 point hedonic scale with the ratings of: 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; and 1 = Dislike extremely. The result was analyzed by statistical software (MSTAT-C).

3 RESULTS AND DISCUSSION

3.1 Sample Recipes:

Table 1. Wheat flour and Soy flour quality from local suppliers

Sl #	Name of the Supplier	Sample code	Wheat flour gluten %	Soy flour Protein %	Moisture %
1	Mat sea flour mill	A	30	36	10.71
2	Mamun flour mill	B	28	35.51	13.56
3	Diamond flour mill	C	34	36.5	12.33
4	Pacific flour mill	D	29	35	13.62
5	City flour mill	E	41	40.09	12.71
6	Sonali flour mill	F	28	33.47	13.78
7	Bashundhara flour mill	G	44	45.66	12.88
8	Anchor flour mill	H	38	37	12.47
9	Raj flour mill	I	30	36.35	13.63
10	Mafiz flour mill	J	32	32.27	11.60

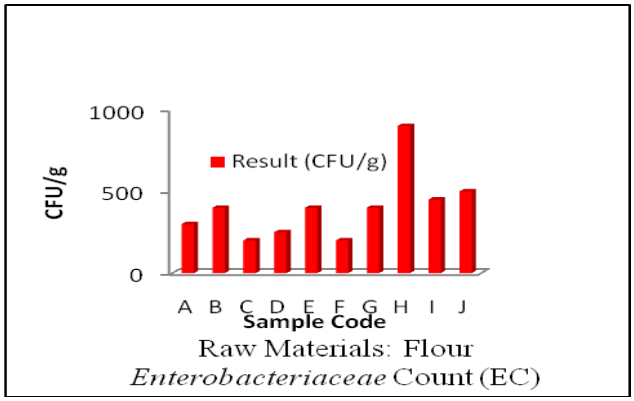
S1 = Bakery Recipe with G coded wheat flour and soy flour

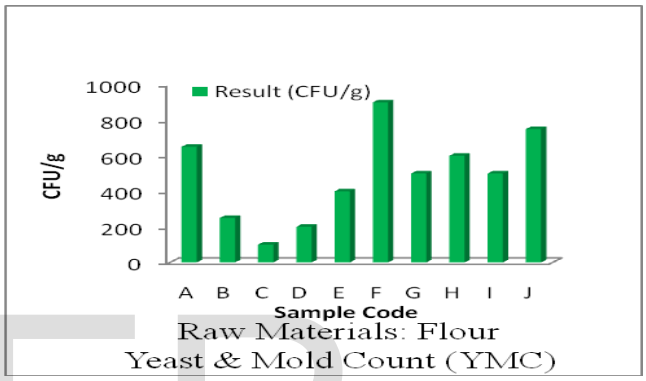
S2 = Bakery Recipe with E coded wheat flour and soy flour

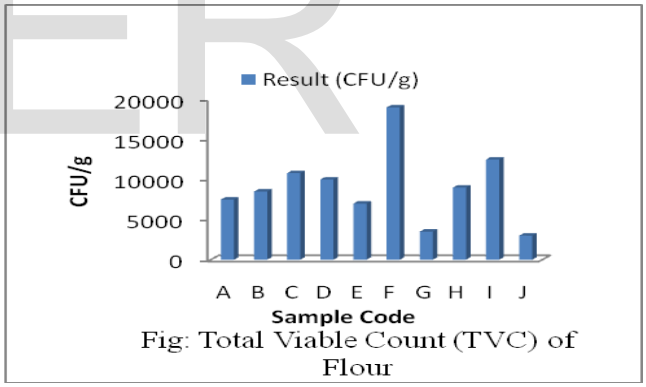
S3= Bakery Recipe with H coded wheat flour and soy flour

3.2 Microbiological Studies of Wheat Flour

Microbiological test of wheat flour was done as sample basis. Different samples coded with A, B, C, D, E, F, G, H, I and J were used as raw material for biscuit processing. Total Viable Count (TVC) was found maximum at F coded flour, Enterobacteriaceae was found maximum at H coded flour, Yeast & Mold count was found maximum at F coded flour. On the contrary, Total Viable Count (TVC) was found minimum at J coded flour, Enterobacteriaceae was found minimum at C & F coded flour, Yeast & Mold count was found minimum at C coded flour.







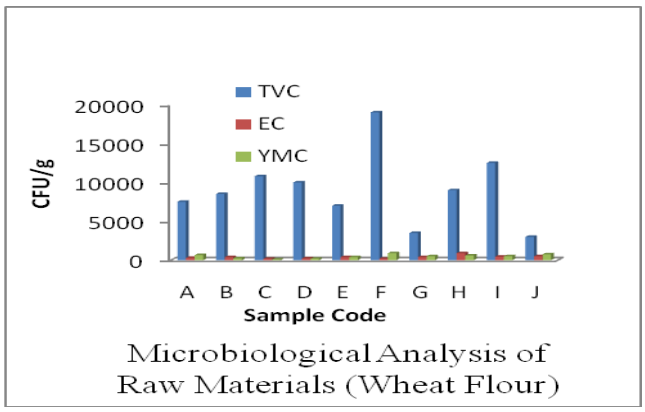


Fig2. Bar diagrams of microbial counts of wheat flour

3.3 Chemical composition and changes of raw material developed products:

The data pertaining to the chemical analysis of high energy fortified biscuits was influenced by different treatments were presented in Table 2.

The data on moisture content reveals that there were significant differences among the samples. Significantly highest moisture content was recorded in sample S1 for 0, 45 and 90 days of storage. Up to 45 days of storage, moisture contents fulfilled the requirement of Bangladesh Standards and Testing Institution (BSTI) which was max. 4.5%. During 90 days of storage, moisture content was just over 4.5% that exceed BSTI requirement. . Significantly highest score for protein and fat content were recorded in sample S1 with the contents of 11.97% protein and 18.55% fat at initial storage; 11.57% protein and 18.33% fat at 45 days of storage; 11.10% protein and 17.30% fat at 90 days of storage. The data on protein and fat contents brings out that there were significant differences among the samples except protein content at initial storage and fat content at 90 days of storage. Protein contents for all the samples met the BSTI requirements but fat contents did not met at 0 and 45 days of storage.

With respect to sucrose and iron content, high energy fortified biscuits revealed that there were significant differences among the samples; significantly highest score for sucrose content was recorded in sample S3 for all the storage days and highest score for iron content was recorded in sample S1 for all the storage days except 0 days of storage. Iron contents satisfied the BSTI requirement at every particular period which was max. 12.65 mg/100g.However, sucrose content satisfied the requirement for all the cases except one which was 15.53 g/100g biscuit.

The moisture and ash were decreased with corresponding increase in the percentage of soy flour [4]. In a previous study, protein and fat contents of biscuits increased with increasing soy fortifications [13].

The data pertaining to the chemical constituents of high energy fortified biscuits was influenced by different days of storage were presented in Table 3.

The data on the table showed that there were significant differences of the chemical constituents among the samples with respect to different days of storage except the protein contents of sample S3, sucrose contents of sample S2, and iron contents of sample S1 and S2. All the constituents decreased over the storage period except the moisture content.

Water activity was more closely related to the physical, chemical and biological properties of foods and other natural products than the total moisture content. Specific changes in colour, aroma, flavour, texture, stability and acceptability of raw and processed food products were associated with relatively narrow water activity ranges [12]. The addition of hydrogenated vegetable oils in convenience foods was found to improve their storage stability [9].

Manley [6] stated that the low moisture content and low water activity of bakery products imparted them a long mold free shelf-life, typically many months.

Table 2. Statistical analysis according to sample

Mean score of Moisture, Protein, Fat, Sucrose and Iron content of different samples at different days of storage.

Days	Test Specification	S1	S2	S3	LSD	Level of sig.	BSTI standard
0	Moisture %	1.98^{a}	1.33^{b}	1.38^{b}	0.2776	**	4.5 max
	Protein %	11.97^{a}	11.41^{a}	11.16^{a}	0.8954	NS	10-15g/100g Biscuit
	Fat %	18.55^{a}	16.93^{b}	16.85^{b}	1.165	**	15-18g/100g Biscuit
	Sugar (as Sucrose) %	12.40^{b}	14.46^{a}	15.13^{a}	1.280	**	10-15g/100g Biscuit
	Iron (as Fe), mg/100 g	10.25^{b}	11.60^{a}	9.713^{b}	1.280	**	9.35-12.65 mg/100g Biscuit
45	Moisture %	3.983^{a}	3.867 ^{ab}	3.55^{b}	0.3206	**	4.5 max
	Protein %	11.57^{a}	10.87^{ab}	10.57^{b}	0.7620	**	10-15g/100g Biscuit
	Fat %	18.33^{a}	16.83^{b}	16.73^{b}	1.087	**	15-18g/100g Biscuit
	Sugar (as Sucrose) %	12.17^{b}	14.23^{a}	14.60^{a}	0.8236	**	10-15g/100g Biscuit
	Iron (as Fe), mg/100 g	11.32^{a}	10.13^{ab}	9.567^{b}	1.210	**	9.35-12.65 mg/100g Biscuit
90	Moisture %	5.00^{a}	4.633^{b}	4.533^{b}	0.3041	**	4.5 max
	Protein %	11.10^{a}	10.60^{b}	10.43^{b}	0.4755	**	10-15g/100g Biscuit
	Fat %	17.30^{a}	16.67^{a}	16.23^{a}	1.163	NS	15-18g/100g Biscuit
	Sugar (as Sucrose) %	11.73^{b}	13.43^{a}	13.90^{a}	0.5735	**	10-15g/100g Biscuit
	Iron (as Fe), mg/100 g	11.20^{a}	10.52^{a}	9.233^{b}	0.7620	**	9.35-12.65 mg/100g Biscuit

Superscripts in common letter in rows do not differ significantly.

** Significant at 1% level.

Table 3. Statistical analysis according to days

Mean score of Moisture, Protein, Fat, Sucrose and Iron content up to 90 days of storage with interval of 45 days.

Test Specification		Days			LSD	CV %	Level of Sig.
		0	45	90			
Moisture %	S1	1.98^{c}	3.98^{b}	5.00^{a}	0.203	36.58	**
	S2	1.33^{c}	3.87^{b}	4.63^{a}	0.110	45.81	**
	S3	1.38^{c}	3.55^{b}	4.53^{a}	0.223	44.49	**
	T	4.69^{c}	11.40^{b}	14.17^{a}	0.390	41.91	**
Protein %	S1	11.97^{a}	11.57^{b}	11.10^{c}	0.219	3.92	**
	S2	11.41^{a}	10.87^{b}	10.60^{b}	0.368	4.55	*
	S3	11.16	10.57	10.43	0.438	3.95	NS
	T	34.53^{a}	33.00^{b}	32.13^{c}	0.980	3.56	*
Fat %	S1	18.55^{a}	18.33^{a}	17.30^{b}	0.180	4.28	**
	S2	16.93^{a}	16.83^{ab}	16.67^{b}	0.083	1.48	*
	S3	16.85^{a}	16.73^{a}	16.23^{b}	0.101	2.37	**
	T	52.33^{a}	51.90^{b}	50.20^{c}	0.176	1.91	**
Sugar (as sucrose)%	S1	12.40^{a}	12.17^{a}	11.73^{b}	0.298	3.58	*
	S2	14.46^{a}	14.23^{a}	13.43^{b}	0.579	4.05	NS
	S3	15.13^{a}	14.60^{b}	13.90^{c}	0.477	4.76	*
	T	41.99^{a}	41.00^{b}	39.07^{c}	0.942	3.55	*
Iron (as Fe), mg/100 g	S1	10.25	11.32	11.20	0.636	6.60	NS
	S2	11.60	10.13	10.52	0.688	7.95	NS
	S3	9.71^{a}	9.57^{b}	9.23^{c}	0.072	2.95	**
	T	31.57	31.02	30.95	0.756	2.88	NS

Superscripts in common letter in rows do not differ significantly.

** Significant at 1% level.

* Significant at 5% level.

3.4 Microbial counts of high energy fortified biscuits:

Table 4. Microbial counts of high energy fortified biscuit samples at initial storage.

Name of the Product	Test Parameters	Result (CFU/g)			Permissible Max. Level (CFU/g)
		S1	S2	S3	
Fortified High Energy Biscuit (FHEB)	Total Viable Count (TVC)	$4x\ 10^2$	$3.5x\ 10^2$	$5x10^2$	10^4
	Enterobacteriaceae (Total coliform)	Nil	Nil	Nil	$<10^2$
	Escherichia coli	Nil	Nil	Nil	3/10g
	Salmonella spp.	Nil	Nil	Nil	0/25g
	Yeasts and molds	Nil	Nil	3	10^2

The data presented in Table 4 indicates that the microbial load of high energy fortified biscuits did not exceed the permissible limit of all the three samples. Total Viable Count (TVC) was highest for the S3 which was 5x102. Total coliform, Escherichia coli, Salmonella spp. , and Yeasts and Molds were not found in the samples except S3 sample contained 3 CFU/g Yeasts and Molds.

3.5 Sensory evaluation

The mean score showed that sample S3 indicates highest score in terms of colour, flavour and texture. From the above results, it was clearly seen that sample S3 treated with H coded flour was the most preferred biscuit with respect to all the quality attributes and as such ranked as "like very much". Though the other samples could be ranked as "like moderately", sample S1 and sample S2 secured the lowest score indicating that were least preferred compared to sample S3 and between the samples S1 and S2, there were no significant difference. It had been also seen that all the samples were acceptable to panelist in all sensory attributes (Table 5).

From the overall acceptance rating, 10% soybean flour incorporated biscuit obtained the highest preference compared to other combinations [4]. Biscuit from wheat and soy flour composite will be acceptable in terms of colour, aroma and overall acceptability [7]. Color is important in flavor and taste recognition and identification, as well as in food preference [5]. However colour scores increased slightly while flavour and mouth-feel decreased slightly as the substitutes increased [13].

Table 5. Mean score for color, flavor, texture and overall acceptability of high energy biscuits

Sample	Sensory attributes			
	Color	Flavor	Texture	Overall acceptability
S1	7.45^B	7.45^B	7.36^B	7.36^B
S2	7.72^B	7.18^B	7.45^B	7.45^B
S3	8.18^A	8.09^A	8.18^A	8.00^A

4 CONCLUSION:

The finding of this re-search revealed that, biscuit produced with S1 bakery recipe had highest chemical composition in terms of moisture%, protein%, fat% and iron content to that of the S2 and S3 bakery sample. Beside this, sucrose content was highest in the S3 sample. During 90 days of storage, fat content showed non-significant difference among the samples but moisture %, protein%, sucrose% and iron content made significant difference. All the chemical parameters of samples fulfilled the requirement of Bangladesh Standards and Testing Institution (BSTI) during 90 days of storage except the moisture contents which were just above the BSTI requirements. This is because of packaging material which was not performed enough to act as moisture barrier after 90 days of storage. Microbial load found in permissible range at initial storage of sample though microbial counts were not taken under consideration during selection of wheat flour. From sensory evaluation, the mean score showed that sample S3 indicates highest score in terms of colour, flavour and texture. It might be because of lowest percent of soy flour protein was used in sample S3. It was also observed that soy flour helped in increasing intake of protein, fat and iron content of the samples.

ACKNOWLEDGMENT

This work was supported by Nabisco Biscuit & Bread Factory Ltd and Bangladesh Atomic Energy Commission.

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