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Research Article

NUTRITIONAL QUALITY AND SHELF LIFE OF RADIATION PROCESSED HEALTH MIX FOR ANAEMIA

Padma KR [1]*, Bindu V [2] and Sarada D [3]
[1] Assistant Professor, Department of Biotechnology, Sri Padmavati Mahila Visvavidyalayam, Tirupati, Andhra Pradesh, India
[2] Assistant Professor, Department of Home Science, Sri Padmavati Mahila Visvavidyalayam, Tirupati, Andhra Pradesh, India
[3] Professor, Department of Home Science, Sri Padmavati Mahila Visvavidyalayam, Tirupati, Andhra Pradesh, India
*Corresponding Author Email: thulasipadi@gmail.com

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ABSTRACT

Anaemia is a wide-reaching communal health quandary affecting both progressing and progressed countries with chief corollary for human health as well as social and economic advancement. Adolescent age group is the casement of possibility to correct the nutritional status of children. If we intercede rightly during this period we can preclude future outcomes of nutritional deficiencies. The aim is to develop and irradiate Health mix and assess the Nutritional quality and acceptability. The material and methods are the Health Mix in two variations (V_1 and V_2) was developed to control Anaemia and promote general Health among the adolescent girls. Each variation consisting of 100 g Health Mix provides two laddus (50 g.laddu), the laddus were prepared with addition of (10 g. Jaggery) and (5 g. Ghee) to 100 g of Health. The result is the variation 1 and 2 of Health Mix was supplemented to Adolescent girls aged between 17 to 19 years and having a Haemoglobin levels less than 10 g%. The sample selected consisted of 70 adolescent girls who were willing to take health mix after irradiation with of low-dose irradiation (at 0.25 kGy and 0.75 kGy of γ- radiation) to improve the microbial safety of Health Mixes developed. The results were statistically analysed by one way analysis of variance with least significant differences procedure at 0.05 levels. The conclusion is the study on "Nutritional Quality and Shelf life of Radiation processed Health mix for Anaemia" among adolescent girls were accepted. The Irradiated Health Mixes did not differ much in their nutritional quality from the non-irradiated samples indicating that the gamma irradiation did not alter the nutrient values as well shelf life of Health mixes.

Keywords: Anemia, Shelf life, gamma irradiation, health mix

INTRODUCTION

The world's adolescent population (age 10–19 years) is anticipated to stand at more than 1 billion, in spite of that adolescents remain a mostly neglected, complex-to-measure, and hard-to-contact population in which the requirements of adolescent girls, specifically, are often ignored[1]. This part of adolescent health has been strenuous to study, and there are numerous unknown factors and consequences for iron deficiency all through adolescence in terms of standards, measurement indicators and health consequences.

In 1993, the World Health Organization (WHO) organized its Safe Motherhood proposal with a goal of dropping the number of maternal deaths by half prior to the year 2000[2-4]. Nevertheless, the World Health Organization (WHO component was to eradicate anemia in pregnancy, concentrating on the larger risk in younger women. In 1997, WHO assembled a regional consultation of experts to address malnutrition problems among adolescent girls in South-East Asia. Amongst the recommendations for action was a need for the development of assessment, advocacy, prevention, and control initiatives, in most countries, to decrease anemia in adolescent girls. As an outcome, WHO training programs for adolescent nutrition have been is a time of intense physical, psychosocial, and cognitive development. Increased nutritional needs at this juncture relate to the fact that adolescents gain up to 50% of their adult weight, more than 20% of their adult height, and 50% of their adult skeletal mass during this period. The iron needs are high in adolescent girls because of the increased requirements for expansion of blood volume associated with the adolescent growth spurt and the onset of. For these reasons, we felt it important to study a population with adequate diets and normal pre-pregnancy iron stores. We investigated the response to supplemental iron in adolescents.

Radiation processing is useful in preservation of food, control of sprouting of items such as potato and onion and control of food-borne diseases. It destroys or inactivates organisms that cause spoilage thereby extending shelf life of certain foods. But foods must be kept in airtight bags to prevent re-infestation. The process is energy efficient. It does not leave any residue. The products remain closer to the fresh state in flavour, colour and texture. The chemical change in food due to radiation processing is so small that it is difficult to design a test to identify whether a food has been irradiated. During the process, no liquid is added; it does not cause loss of natural juices. Large or small amounts of foods can be irradiated in appropriate containers[5].

Ionizing radiation can change food quality but in general very high levels of radiation treatment (many thousands of gray) are necessary to adversely change nutritional content, as well as the sensory qualities (taste, appearance, and texture). Irradiations to the doses used commercially to treat food have very little negative impact on the sensory qualities and nutrient content in foods. When irradiation is used to maintain food quality for a longer period of time (improve the shelf stability of some sensory qualities and nutrients) the improvement means that more consumers have access to the original taste, texture, appearance, and nutrients[6-8]. The changes in quality and nutrition depend on the degree of treatment and may vary greatly from food to food[9-10].

Adolescence is a time of intense physical, psychosocial, and cognitive development. Increased nutritional needs at this juncture relate to the fact that adolescents gain up to 50% of their adult weight, more than 20% of their adult height, and 50% of their adult skeletal mass during this period. The iron needs are high in adolescent girls because of the increased requirements for expansion of blood volume associated with the adolescent growth spurt and the onset of menstruation[11]. For these reasons, we felt it important to study a population with adequate diets and normal pre-pregnancy iron stores. We investigated the response to supplemental iron in adolescent's girls.

MATERIALS AND METHODS

Selection of Health Mixes

For the present study the ingredients selected includes Ragi (*Eleusine coracana*), Wheat (*Triticum aestivum*), Rice flakes (*Oryza sativa*), Bengal gram (*Cicer arietinum*), Green gram whole (*Phaseolus aureus* Roxb), Black gram (*Phaseolus mungo* Roxb), Horse gram (*Dolichos biflorus*), Cowpea (*Vigna catjang*), Soya (*Glycine max*), and Sesame seeds (*Sesamum indium*) were procured from local market in Tirupati, Andhra Pradesh.

Formulation, Development and Standardization of Health Mix

The Health Mix was formulated using the blending of multigrain such as cereals/ Cereal products, Millets, pulses/ legumes and oil seeds. All the ingredients were cleaned for dust and other extraneous materials and stored at room temperatures in an air tight container until further use. These Health mix were developed with a purpose to provide nutritionally high biological value foods, proteins and concentrated source of energy along with micro nutrients and fibre. The Health mix were developed using home level processing methods such as cleaning, washing, sprouting, drying, roasting to enhance the taste, flavour, acceptability and digestibility of nutrients and milling. All the ingredients were finely coarsely powdered and developed into Health mix with various combinations and proportions in the Department of Home science Laboratory.

A standard recipe is that which establishes procedures that will make possible production of high quality foods to be served for consumption.

For standardization two recipes with two variations each were formulated and served to the panel member's. The panel members evaluated the product according to the score card and gave remarks. Based on the remarks the recipes were modified and presented.

Composition of Health Mix

The Health Mix in two variations (V_1 and V_2) was developed to control Anaemia and promote general Health among the adolescent girls. Each variation consisting of 100 g Health Mix provides two laddus (50 g.laddu), the laddus were prepared with addition of (10 g. Jaggery) and (5 g. Ghee) to 100 g of Health Mix. The Health Mix formulated does not contain Jaggery and Ghee, as it was subjected to further investigation such as irradiation and shelf life. The combination and proportion of food materials used for each variation is as under Table 1.

Table 1: Composition of Health Mix

Food Materials	Health Mix	
	Variation -1	Variation -2
Whole Wheat flour	20 g	25 g
Rice flakes	25 g	25 g
Sprouted Ragi flour	20 g	25 g
Soya flour	5 g	3 g
Roasted Bengal gram	5 g	5 g
Cowpea	5 g	3 g
Black gram	5 g	3 g
Horse gram	5 g	3 g
Green gram whole	5 g	3 g
Gingelly seeds	5 g	5 g
Total	**100 g**	**100 g**

The food materials/ingredients included in the recipe of Health Mix were procured weighed, cleaned, washed, sprouted, sun dried, roasted and powdered coarsely. The two laddus prepared with 100 g of health mix, 10 g of Jaggery and 5 g ghee were subjected to organoleptic evaluation.

Sensory Evaluation

Quality is the ultimate criterion of the desirability of any food product. When the quality of food product is assessed by means of human sensory organs the evaluation is said to be sensory or subjective of organoleptic evaluation.

For sensory evaluation five point Hedonic scale test used to find out the overall acceptability of each sample and test scores were assigned for quality attributes like appearance, flavour, texture and taste and overall acceptability.

Selection of Panel members for Sensory Evaluation

The panel members for sensory evaluation selected consisted of eight women and two male members drawn from different backgrounds from Teaching Faculty, Nutritionist, Medical personnel, Housewives and Chefs, based on the following criteria:

- Aged between 25-45 years.
- Non smokers, non betel leaves chewing and do not have the habit of taking any other chewing material.
- Without food allergies

The oral consent of the panel members was taken for evaluating both Non- Irradiated and Irradiated Health Mix (with two variations; V_1 and V_2).

Ethics approval and consent to participate

The study is carried out as per International conference of Harmonization-Good Clinical Practices Guidelines (ICH-GCP) or as per Declaration of Helsinki guidelines.

Preparation Score card for Sensory Evaluation

Hedonic scale was selected which is a preference test for testing the acceptability. Hedonic method is one where the judge expresses the degree of liking by checking a point on the scale ranging from Excellent to Poor. Separate column was given to write remarks.

The score card for sensory evaluation of products prepared with Health Mix was designed on the lines of criterion matrix to be evaluated on a five point scale as under;

Table-2 Score card for Sensory Evaluation

Product code:						
S. No.	**Sensory Evaluation attributes**	**Excellent 5**	**Very good 4**	**Good 3**	**Average 2**	**Poor 1**
1.	Appearance					
2.	Texture					
3.	Flavour					
4.	Taste					
5.	Overall acceptability					
6.	Remarks					

The panel members were oriented on the scoring method

Acceptability of Developed Health Mix through Sensory Evaluation

The Sensory evaluation of Health Mix were conducted in two stages, in stage 1 the Non- irradiated Health Mix with variation 1 and 2 were prepared and subjected to sensory evaluation. Based on the results or mean scores of sensory evaluation variation 1 of Health Mix were selected for r-radiation in doses; 0.25 kGy and 0.75 kGy. The Irradiated Health Mix was subjected to sensory evaluation by the same panel. The time gap between the first and second sensory evaluation was 20 days.

The panel members were served coded products prepared Health Mix one after the other individually, along with a glass of water and sensory evaluation card. While serving the coded products for evaluation, care was taken to maintain a time gap of 15 minutes between service of each product, paper napkins and hand each facilities was also provided, The products subjected to Sensory Evaluation included.

Table 3: Sensory Evaluation for the developed products before and after Irradiation

S.No	Health Mix and Variation	Type of product	No of Portions	Weight (g)	Code
1.	Non-Irradiated Health Mix - variation 1	Laddu	1	50g	E
2.	Health Mix- variation 1, Irradiated @ 0.25 kGy	Laddu	1	50g	F
3.	Health Mix- variation 1, Irradiated @0.75 kGy	Laddu	1	50g	G
4.	Health Mix variation 2	Laddu	1	50g	H

Testing the shelf life of the Health Mixes developed before and after irradiation

Dilution plate technique the dilution plate count is the most frequently used technique for determining the number of viable microbial in samples and in addition may be used a method. The method of procedure was enclosed in (Annexure I).

The variation 1 of Health Mix was selected for production and supplementation to the selected sample. The shelf life of both the Health Mix Non- Irradiation and irradiated were evaluated after 15 days, 30 days and 120 days. The Health Mix were stored at room temperature (from January to April 2018) in quantities of 500 g packed in polythene covers, sealed and labelled

The shelf life of Non-irradiated and Irradiated Health Mix was tested by analysing their Microbial assay. The results of Microbiological analysis of Health Mix were presented and discussed under Results and Discussion.

Table 4: pH and Rancidity of the Health Mix

S. No	Sample	pH and Rancidity of the Health Mix					
		pH			Rancidity		
		Non-Irradiated	Irradiated @0.25kGy	Irradiated @0.75kGy	Non-Irradiated	Irradiated @0.25kGy	Irradiated @0.75kGy
1.	Fresh sample	7.0	7.2	7.4	0.28	0.20	0.22
2.	15 days old	6.4	6.8	7.2	0.31	0.29	0.24
3.	30 days old	6.0	6.2	6.4	0.46	0.38	0.31
4.	120 days old	4.2	5.8	6.2	1.68	1.32	1.02

The table 4 show the pH and rancidity of the Health Mix for (Adolescent girls). The results in the table showed that the pH of the samples decreased as the Shelf life increased both for the non-Irradiated and irradiated samples. The pH of the Health Mix samples Irradiated at 0.75 kGy indicate that the shelf life is not poor as the pH was 6.0 to 6.2 and gamma -radiation is useful in presentation of Health Mix as they improve the shelf life of the products with regard to the rancidity in the Health Mix, the levels of rancidity is more in non-irradiated health mix than the irradiated samples. The rancidity levels were slightly more in Irradiated samples of Health Mix; this may be due to the presence of powdered gingerly seeds in Health Mix. These results reveal that the gamma- radiation has an effect on rancidity of the food products also.

Statistical Analysis

All statistical analysis was done in triplicate and average values are calculated. Data were presented as mean ± Standard Deviation. The results were statistically analysed by one way analysis of variance and means were compared using Bonferroni post hoc test with least significant differences procedure at 0.05

levels were used to describe the significance of differences between control and irradiated samples. Graph pad prism 3.1 version was used as statistical analysis software.

RESULTS AND DISCUSSION

Sensory Evaluation of Health Mix before and after irradiation

Table 5: Comparison of the mean scores for sensory evaluation of irradiated and non-irradiated Health Mix

S. No.	Sensory evaluation attributes	Non Irradiated Health Mix	Irradiated Health Mix	
			Variation 1 Mean Score	Variation2 Mean score
1	Appearance	4.2	4.2	4.1
2	Texture	4.2	4.2	4.2
3	Taste	4.3	4.2	4.2
4	Flavour	4.4	4.3	4.2
5	Overall acceptability	4.3	4.2	4.2

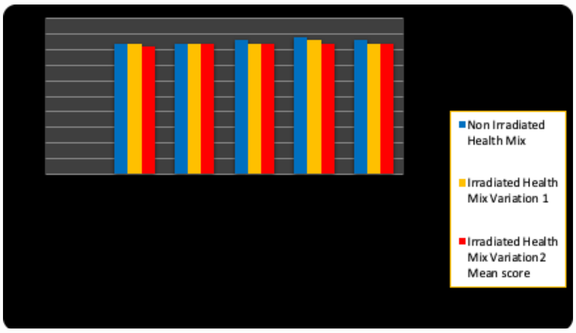

Figure 1

Table 5 and Figure 1 indicate that there was negligible difference among the mean sensory evaluation scores of non-irradiated (at two doses) Health Mix for 5 attributes. This reveals that there is not much difference among the irradiated and non-irradiated Health mix product. Further sensory evaluation mean scores were between 4 to 5 for all the attributes indicating that; they were rated as very good by panel members and 5 point hedonic scales.

Hence the null hypothesis HO_2 "The Health Mix do not differ in Acceptability after Irradiation" is accepted.

The calculated and chemically analysed Nutrient composition of Health Mix

The nutritional quality of Health Mix before irradiation was calculated using the Nutritive Value of Indian Foods[12-20] and also analysed standard procedures and presented in Table 6 and Figure 2.

Table 6: Comparison of Nutritive value of Health Mix before radiation

S. No.	Nutrients	Health Mix	
		Calculated value*	Actual value**
1.	Moisture (g)	11.725	9.10
2.	Proteins (g)	14.052	13.90
3.	Fats (g)	4.187	5.46
4.	Carbohydrates (g)	65.033	71.54
5.	Energy (K cals)	348.16	348.16
6.	Iron (mg)	9.9405	9.10
7.	Calcium (mg)	207.09	210
8.	Thiamine (mg)	0.408	0.42
9.	Riboflavin (mg)	0.1722	0.1722
10.	Fibre (g)	2.328	2.28

* As calculated using nutritive value of Indian foods (ICMR, 2010) **As analysed using standard procedures (AOCC, 2005)

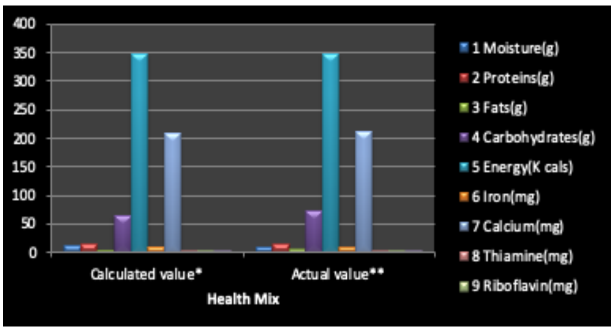

Figure 2: Nutritive value of Health Mix before radiation

The Table 6 and Figure 2 shows that there was not much difference in the values of nutrients (calculated manually and chemically analysed) of samples of non irradiated Health mix before irradiation in Thiamine, Riboflavin, fibre and fat. There was slight variation in the values of nutrients; protein, carbohydrates, iron indicating that both the ways the food samples need to be analysed to know the difference in the nutrient composition.

Similarly there was not much difference in the values of nutrients (calculated manually and chemically analysed) of samples of non irradiated Health mix before irradiation in Thiamine, Riboflavin, iron and fibre. There was slight variation in the values of nutrients; protein, carbohydrates and calcium. This may be due to the quality of food materials used in preparation of Health Mix. The actual nutrient composition may be influenced by the soil in which the food is grown, fertilizers used in agriculture and practices followed in pre, post harvesting of foods.

Nutrient composition of Health mix after irradiation

The nutrient composition of Health mix after irradiation at two doses namely; was analysed and compared for their nutrient composition in order to study the difference in gamma radiation doses on nutritional quality, which is presented in Table 7.

Table 7: Nutrient composition of Health mixes after irradiation

S. No.	Nutrient Composition after irradiation after irradiation		
	Nutrients	Health Mix (0.25 kGy)	Health Mix @ (0.75kGy)
1.	Moisture (%)	8.52 ± 0.04	8.68 ± 0.04
2	Ash (%)	3.20 ± 0.04	3.24 ± 0.04
3.	Proteins (g)	13.48 ± 0.04	13.52 ± 0.04
4.	Fats (g)	4.13 ± 0.04	4.20 ± 0.04
5.	Carbohydrates (g)	70.57 ± 0.04	74.70 ± 0.04
6.	Iron (mg)	4.13 ± 0.04	4.20 ± 0.04
7.	Calcium (mg)	198.3 ± 0.04	199.2 ± 0.04
8,	Thiamine (mg)	0.80 ± 0.04	0.81 ± 0.04
9.	Riboflavin (mg)	0.112 ± 0.04	0.116 ± 0.04
10.	Fibre (g)	2.15 ± 0.04	2.10 ± 0.04

The Health mix did not differ in their nutritional quality before and after irradiation at two low doses (0.25 kGy and 0.75 kGy) ,that is there is not much difference in non irradiated and irradiated health mix except for slight variation in nutrient values protein, carbohydrates, iron and calcium. Hence **the null Hypothesis H0$_4$ "The Health Mix after irradiation do not differ in nutritional quality" were partially accepted.**

Shelf life of Health Mix before and after Irradiation

The Shelf life of Health Mix (Variation 1) and (Variation 2) was assessed by microbiological analysis, pH and rancidity. The microbial growth in the Fresh Health mixes and preserved (for 15 to 120 days) Health Mixes were examined for number of colonies formed on the Agar plate. The Non- Irradiated sample that is the fresh sample at 24 h exposure resulted in 4 x 10^3 CFU/g and when irradiated with 0.25 kGy and 0.75 kGy the CFU/g in fresh sample was 1 x 10^3 but in 15 days, 30 days and 120 days old sample the CFU/g was shown in Figure and Table 4 and 5. Which clearly signifies that samples when exposed to 0.25 kGy showed decrease in CFU/g. when compared with fresh sample but more significant decreased observed in 0.75 kGy product. When samples were incubated at 48 hours the Non- Irradiated product showed. The colonies as shown in Figure and Table comparatively the 0.25 showed decrease in CFU/g and much reduction was observed with 0.75 in 120 days old sample at 0.75 were more resistant against occurrence microbiological agents. Thus from the technological point of view, the low level of microorganisms due to increased exposure increased the shelf life of product.

The microbiological analysis was expressed in terms of Colony Forming Units per gram and the CFU/g of all the samples was compared. The more the CFU/g; the lower the shelf life of the health mixes[21-23].

Table 8: Microbiological analysis of Health Mix (Non- Irradiated and Irradiated)

S. No.	Sample	Microbial growth					
		24 hours of incubation (CFU/g)			48 hours of incubation (CFU/g)		
		Non-Irradiated	Irradiated @0.25 kGy	Irradiated @0.75 kGy	Non-Irradiated	Irradiated @0.25 kGy	Irradiated @0.75 kGy
1.	Fresh sample	$4x10^3$	$1x10^3$	$0.7x10^3$	$6x10^3$	$2x10^3$	$1x10^3$
2.	15 days old	$8x10^3$	$3x10^3$	$2x10^3$	$1.8x10^3$	$4x10^3$	$2x10^3$
3.	30 days old	$25x10^3$	$2x10^3$	$1x10^3$	$0.9x10^3$	$3x10^3$	$1.2x10^3$
4.	120 days old	$36x10^3$	$0.6x10^3$	$0.5x10^3$	$0.4x10^3$	$0.8x10^3$	$0.7x10^3$

The results of Micro biological analysis indicate that the Irradiated Health Mix had lower CFU/g of the sample, when compared to Non- Irradiated samples of Health Mix. Which reveals that the γ-radiation at doses of 0.25 KGy and 0.75 kGy were effective in improving the shelf life of the Health mix. Hence **the null hypothesis H0$_5$ "There is no difference in Shelf life of Health Mix before and after Irradiation"** and **the null Hypothesis H0$_6$ "There is no difference in shelf life of Health Mix before and after Irradiation" were rejected.**

CONCLUSION

The Present study on "Nutritional Quality and Shelf life of Radiation processed Health mix for Anaemia" is an experimental research conducted in seven phases. The variation 1 of Health Mix was supplemented to Adolescent girls aged between 17 to 19 years, studying in Junior and Degree Colleges and having a Haemoglobin levels less than 10 g%. The study on Nutritional Quality and Shelf life of Radiation processed Health mix for Anaemia foods conducted by developing Health Mix for adolescent girls were accepted and rated as very good. The Irradiated Health Mixes did not differ much in their nutritional quality from the non-irradiated samples indicating that the gamma irradiation at doses 0.25 kGy and 0.75 kGy did not alter the nutrient values of Health mix.

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