J. Agric. Sci. Mansoura Univ., 25 (6): 3473 - 3492, 2000.

CHANGES IN THE PHYSICAL PROPERTIES OF IRRADIATED LEGUMES AND THEIR SOUP POWDERS

Emam, Wafaa H.; S.A. Salem and H.A. Moharram
Food Tech. and Dairy Dept. National Res. Centre. Dokki, Cairo. Egypt.

ABSTRACT

The effect of gamma irradiation on some selected physical properties were studied in five Egyptian legumes; Faba beans , lentils , French Beans, Cowpeas and Chickpeas as well as their soup powders. This effect was illustrated in two levels; the first level was at 1 KGy (which is considered to be the safe and appropriate dose for insect disinfestation; the other doses were applied at 5, 10 KGy to search for an irradiation indices.

The data in samples irradiated at 1 KGy showed a little effect on the enhancement of water absorption rate in all the studied legumes. Also irradiation at the same dose level caused softening effect on the legumes and improved the cooking process.

The rate of water absorption and color measurements are among the parameters which correlated with different irradiation doses. Changes in the color of irradiated legumes were observed to be dependent on the variety of the studied legumes. Irradiation had a great influence (P<0.01) on color attributes (a*, L*, b*) of Lentils, Cowpeas and Chickpeas. The other varieties; Faba beans and French beans showed no significant results towards changes in color as function of different irradiation doses. Organoleptic evaluation of both the irradiated legumes and their soups revealed changes in the color characteristics and off flavor as observed by most of the panalists.

Keywords: Gamma irradiation-Egyptian legumes-Cooking time-Water absorption-Color attributes

INTRODUCTION

Legumes are rich sources of easily available; cheap protein and complement cereal proteins in terms of essential amino acids.

Deterioration of legume seeds quality as a function of time and condition of storage has been described in literature by many investigators (Antunes and Sgarbieri 1979). The factors responsible for the deterioration have been identified as high water content or relative humidity and temperature in the storage environment (Mejia 1982). All these factors made the stored legumes to be susceptible to high losses due to insect attack; so irradiation treatment (1KGy) has been proposed as a method by different institutions. (International project in the field of food irradiation news 1990) for the disinfestation of legumes; without causing unfavorable nutritional consequences. Storage of the legume seeds in the polyethelene bages of a thickness greater than 100 mm avoids all recontamination by this insects (Diop et al 1997). It was concluded by several authors that 1.0 KGy is the preferred dose for the control of insects for storage period for up to 6 months. (Roy and Prasad 1993). Furthermore legal clearance for irradiation of legumes is given in a number of Asian and South American countries, China and Netherlands. (Hossain 1994).

From the nutritional point of view (Delincee and Bognar 1993) emphasized that apparently net protein utilization (NPU), digestibility (D) and biological value (BV) of irradiated legumes determined by using a rat feeding trial; have a little effect on protein quality of foods at doses less than 10 KGy. In general irradiation at doses up to 1 KGy for the purpose of insect disinfestation will not result in significant adverse effects on vitamin B content or protein quality of legumes studied. There are reports of an improvement in the nutritional values of irradiated legumes (Diehl, 1991). The availability of riboflavin was considerably improved in beans, treated with a dose of 1KGy. With little effect on thiamin and pyridoxine content. (Khattak and klopfenstein 1989).

Irradiation can improve the quality of legumes through enhancing the digestibility by reducing the flactulance; causing oligosacchandes; raffinose; stachyose and verbacose (Streenivassen 1974). Accelerated degradation of oligosaccharids to monosaccharides such as glucose and fructose means that legumes are more easily digested by the gastrointestinal tract.

Gunha et al (1993); emphasized the advantages of gamma irradiation treatment to prolong the shelf life of dry bean stored at 30ºC, 75% RH.

The present study was undertaken to evaluate the kinetics of physical properties (i.e. water absorption, color measurements and organoleptic properties) of five selected varieties of Egyptian legumes: Faba beans , Lentils, French beans, Cowpeas and Chickpeas as well as their soup. powders as affected by different gamma irradiation treatments. The applied doses were at:-

1- 1 KGy the safe and appropriate dose for insect disinfestations.
2- Other higher doses (5,10 KGy) were also applied to determine the changes in the aforementioned physical properties of these legumes at various dose levels, so from these properties; is it possible to apply an irradiation indices or not ?.

MATERIALS AND METHODS

1- Materials

A full mature seeds of Faba beans (*Vicia faba*); Lentils (*Lens esculenta*); French beans (*Phaseolus vulgaris*); Cowpeas; (*Vigna spp*); and Chickpeas (*Cicer arietinnum*) were obtained from the Agriculture research centre; Horticulture Department. The seeds were kept under refrigeration (10ºC) prior to use.

2. Methods

2.1. Irradiation process

The seeds (100g) were packed in individual polyethylene bags and irradiated at two different levels. The first level was at 1 KGy; the safe and appropriate for insect disinfestation; the other levels were at 5 and 10 KGy doses. This process was carried out at 25ºC in a cobalt-60- Gamma irradiation unit of National Center for radiation research and technology (NCRRT). The dose rate was 0.6 $KGy.hr^{-1}$

2.2 Processing Methods

2.2.1- Soaking:

Both the irradiated and non irradiated legume seeds were soaked at 25ºC with distilled water using (1:5 w/v, legumes to a water ratio) for 1, 3, 6, 12 and 16 hrs at room temperatures (25ºC$\pm$2ºC).

2.2.2. Cooking

Legume seeds were cooked also with distilled water under pressure and autoclaved at 120ºC using a seed: solution ratio of 1:25 w/v for 10, 20, 30 and 40 min.

2.2.3 Soup powder preparation

Legume seeds were processed individually; they were cooked in a small amount of water in a pressure cooker pan. They were processed until cooked soft. A lab tray cabinet driver was used in dehydration of all the cooked materials. Materials were spread on aluminum trays (40 $\times$ 60cm) in a thin layer (about 3-4 mm thickness); put in an air ventilation oven at 60º-70ºC for individual legume samples. Dehydration was continued until dried. Samples were ground to a fine flower in a laboratory grinding machine; then sieved through a silk sieve to about 95% extraction ratio by weight; tightly packed in polyethelene.

2.3. Measurement of the physical properties:

physical properties were determined according to Williams et al 1983 with the modifications described by (Aclemente et al 1998) as follows:-
Seed weight was calculated as the mean weight of 100 undamaged seeds.

Seed volume was determined by displacement.

After soaking, excess water was drained and measures for water absorbed (g water absorbed. g dry $matter^{-1}$) were carried out.

2.4. Color Measurement

Color measurements of the studied legumes were conducted immediately after irradiation. The legume samples were ground before measuring the change in color. Measurements were conducted using a hunter labscan XE colorimeter. The labscan XE is a full- scanning spectro-colorimeter with a wavelength range from 400-700 nm (Hunter, laboratory, Inc Reston, VA). This instrument was standerdized prior to each use by white tile. The white standard tile were (X= 77.26, Y= 81.94 and Z=88.14).

Commission Internationale d`Eclairage (CIE) L* (Lightness), a* (redness), b* (Yellowness) were measured. Also a*, b* were ~~calcula~~ted as due angle (coloration), Tan^{-1} (b*/a*), chrome [hue radius: $\sqrt{(a^{*2}+ b^{*2})}$. Color difference ΔE were calculated by:

$$\Delta E= [(L^*-L_{ref})^2+(a^*-a_{ref})^2+ (b^*-b_{ref})^2]^{1/2}$$

The control samples were used as a reference values (Francis and Glydesale, 1975). Reflectance measurements were collected at 10 nm increment using illuminate A.

2.5. Sensory evaluation of both legumes and soup powder.

The panelists were asked to rate the sample for their saturation, lightness, visual quality and off flavor on a score card. Quantitative descriptive analysis (Stone et al 1974) was used to quantify the perceived responses:

- Saturation: referred to the intensity of color represented by high or low extreme ends of the scale.
- Lightness: referred to the extent of gray in the color with dark light defining the extremes of the rating scale.
- Visual quality of the product related to the overall, Judgement based on color and appearance of the product.

As it was previously noticed by (Rao and Vakil 1985); that 10 KGy; had a distinct discoloration and irradiation flavor; these samples were not served to the test panel.

Subjective evaluation of the texture and hardness was also carried out as described by (Aclemente et al 1998). Using the following numerical scale:

1-2-: very hard
3-4: hard
5-6 : partially soft
7-8 : Soft
9-10: Cooked

2-6 Statistical analysis

The experiment was replicated three times: Experimental results were analyzed with the statistical analysis system (SAS Institute Inc 1985) by general linear model . Analysis included the use of analysis of a variance to investigate the effect of different doses on the physical properties of legumes. In addition regression techniques (Drapper and Smith 1981) were also applied. Student T-test was also used to test the significance of the data at alpha level ($P<0.05$) and ($P<0.01$).

RESULTS AND DISCUSSION

3.1 Water Absorption

3.1.1: At safe dose (1 KGy):

Figs (1,2) showed the changes that occurred in the water absorption. It was shown in all studied legumes that the rate of water absorption was

enhanced approx. one fold in case of both soaking and cooking time. Also the optimal cooking time in both faba beans and chickpeas were reduced by approx. 25% and 6% respectively.

3.1.2 At higher doses

3.1.2.1: Effect of soaking time:-

Soaking is necessary prior to cooking and it has an influence effect on texture in several legumes as has been reported by (Aquirre-terrazaz et al 1992, Anzaldua- Moarles et al 1996). fig (1) illustrated the changes in the kinetics of water absorption in different Egyptian legumes as a function of applying different irradiation dose. The kinetics of water absorption in all the irradiated legumes along the soaking time were studied. Soaking for all the irradiated legumes were characterized by a rapid water uptake during the first 8 hrs: followed by a marked decrease in the hydration rate to a saturation point (Aclemente et al 1998). All the changes that occurred in the water absorption along soaking time as a function of different irradiation doses (1, 5, 10 KGy) were found to be significant ($P< 0.05$) since their rates were getting higher as a result of increasing radiation doses in all the studied legumes. These results are in agreement with those obtained by El-Saadany (1972) and Mahrous (1983) who mentioned that the increase in water absorption capacity (WAC) could be due to modification of the protein structure which consequently affect the absorption of the treated foods.

Correlation coefficients between water absorption and irradiation doses (KGy) at different soaking time are listed in table (1). Changes in the water absorption (g.water. g dry matter)$^{-1}$ was significantly influenced ($P<0.05$) by irradiation doses at 1,3, and 12 hrs soaking time in case of faba beans; at 12, 16 hrs in case of lentils and at 1, 3, 12 hrs in case of French beans, cowpeas and chickpeas. These differences could be due to the relative varieties ability of the legumes to reach the saturation points. Also these changes could be also related to the ability of different legume seeds to be penetrated by gamma irradiation and hence a change in the texture of the seed became obvious. Changes in the texture that occurred during processing result from changes in the chemistry of this hydrophilic polymeric material that affect the physical properties. The chemistry of these changes is complex. For example; pectin can be depolymerized and destrified by heat or any other physical means; it can be crosslinked by means of divalent cation salt bridge formation between the free carboxylic acid groups on the polygalacturonic acid chains and cations (Ca^{++}) naturally present in the tissue or added during processing. Depending on which of these reactions occur; Vegetable tissue may become softer or firmer during processing **(**Van Bourne 1989).

3.1.2.2 Effect of Cooking Time

Fig (2) illustrated the influence of cooking time on water absorption as function of different irradiation doses. The relationship between water absorbed during cooking and cooking time was apparently linear at all the irradiation levels ($R^2>0.90$). Differences in water absorption rate as a result of increasing radiation doses were observed. Irradiation enhanced the water

absorption during cooking in all the studied legumes compared to the control sample.

Each variety of the studied legumes respond differently towards water absorption rate against cooking time at different irradiation doses. The effect was minimal in faba beans, chickpeas and cowpeas and higher in case of French beans and lentils. All these differences could be probably with the pectins of the middle lamella of the cotyledon cells to form Ca-pectinates that reduce the absorption of water and increases the cooking time. (Hentges et al 1991). Irradiation of beans caused the softening of the seeds; which confirmed involvement of the cell wall middle lamella in hardening of beans seeds (Garcia et al 1993).

Table (2) showed the correlation coefficient between the changes in water absorption and different irradiation doses at different cooking time. The data showed a significantly ($P<0.05$) positive correlations towards enhancing the absorption of water at 20 min in Faba beans, at 10 min ($p<0.01$) in lentils and in all the studied cooking times (mins) ($p<0.05$) in other legumes.

Table (1): Correlation coefficients between water absorption (g. water absorbed. g dry matter^{-1}) and irradiation doses (KGy*) at different soaking time (hrs).**

	Soaking time (hrs)			
	1hr	2hr	12hr	16hr
Faba beans				
S.E.	0.017	0.054	0.185-	0.226
R^2	0.971*	0.9927**	0.895*	0.838
Lentils				
S.E.	0.0218	0.0332	0.0500	0.045-
R^2	0.934	0.814	0.9011*	0.906*
French Beans				
S.E.	0.0129	0.036	0.088	0.087
R^2	0.969*	0.972*	0.971*	0.970*
Cowpeas				
S.E.	0.0096	0.088	0.124	0.175
R^2	0.997**	0.966*	0.961*	0.917*
Chickpeas				
S.E.	0.046	0.065-	0.025-	0.086
R^2	0.824*	0.930*	0.990*	0.960*

S.E. standard error *** Significance at 5%.** **** significance at 1%.**
R^2: Correlation coefficients ***** the doses were at 0,1, 5, 10**

Table (2): Correlation coefficients between changes in water absorption (g. water absorbed . g dry matter^{-1}) and irradiation doses (KGy*) at different soaking time.**

	Cooking time (hrs)			
	10	20	30	50
Faba beans				
S.E.	0.0062	0.0079	0.029	0.085-
R^2	0.846	0.907*	0.839	0.795-
Lentils				
S.E.	0.0015-	0.09	0.123	
R^2	0.987**	0.675	0.849	
French Beans				
S.E.	0.105-	0.135	0.302	
R^2	0.903*	0.959*	0.921*	
Cowpeas				
S.E.	0.092	0.095-	0.101	
R^2	0.969*	0.968*	0.965*	
Chickpeas				
S.E.	0.0044	0.031	0.043	0.029
R^2	0.932*	0.905*	0.906*	0.916*

S.E. standard error *** Significance at 5%.** **** significance at 1%.**
R^2: Correlation coefficients ***** the doses were at 0,1, 5, 10**

Table.(3) Optimal cooking time (min) of both Faba beans and chickpeas as affected by different irradiation doses.

KGy	Faba beans	Chickpeas
0	45.66	22.25
1	36.45	20.97
5	33.33	17.60
10	30.98	16.73

3.1.2.3 Determination of the optimal cooking time:

for the determination of the optimal cooking time; the data were applied on Faba beans and Chickpeas legumes because these types of legumes took a relatively longer cooking time than the other types of the studied legumes. The data were simulated using the first order plot as seen in fig (3). From this plot it can be concluded that irradiation reduced significantly ($P<0.05$) the cooking time in both the Faba beans and chickpea legumes as indicated in (table 3). Gunha et al (1993) emphasized also that irradiation (2 KGy) contributed significantly to soften the beans seeds; therefore decreasing the cooking time; the softening effect of gamma radiation on beans and other cereal grains has been reported by (Carvalho et al 1991). Gamma irradiation reduced also the development of the hard to cook and hard shell defects in beans stored for 2 yrs (Mancini et al 1995) also Jung Kang and Woo Byun (1996) found that in his study on soybeans seeds that irradiation at 5-20 KGy resulted in a reduction of 55-75% of the cooking time needed as compared to the non irradiated soybeans.

3.2. Instrumental color measurements:

3.2.1 At safe dose (1 KGy).

As seen from figs (4,5); irradiation at 1 KGy caused slight changes in the color values of all these studied legumes compared with the control samples and even in the soups made from these irradiated legumes; differences were hardly ever noticed.

3.2.2 At higher doses.

The hunter L*, a*, b*, ∆E, H* (coloration) and chroma of irradiated legume seeds and soups made from these seeds were compared by different irradiation doses. The data were shown in fig (4) and fig(5), table (4) showed the significance of these data towards different irradiation doses.

As indicated from table (4); increasing irradiation dose levels has no significant effects on faba beans; French beans; and chickpeas lightness values except in case of cowpeas; (fig 4) and lentils soup (fig 5) where the data showed a significant ($P<0.01$) reduction and ($P<0.05$) significant increment respectively in L* values as irradiation dose increased.

Redness values (a*) (fig 4) for both cowpeas and chickpeas were affected similarity as a result of irradiation. The amount of redness in the above two mentioned legumes were significantly ($P<0.05$) increased and decreased ($P<0.05$) respectively as dose level raised from 0 to 10 KGy. The other varieties of legumes showed no responses.

The amount of yellowness (b* value) in both lentils fig (4) and French beans soups fig (5) were greatly influenced by different irradiation doses. In lentils; the amount of yellowness (b*) values was lower ($P<0.05$) whereas in the French beans soups; they showed a higher rate ($P<0.05$) as a result of increasing irradiation doses, The other kinds of legumes showed no sensitivity in b* as a result of different doses of gamma irradiation.

Irradiation has also a great responses towards total color change (∆E) in certain types of legumes and their soups. It exhibited a positively strong total color changes (fig 4) ($P<0.01$) in cowpeas and ($P<0.05$) in chickpeas as well as in lentils and ($P<0.05$) in French beans soups ($p<0.05$) fig (5).

The changes in the color of the soups could be attributed also to the effect of heat as well. The other kinds of legumes as it seemed, they have a great tolerance towards irradiation doses. No changes were found.

An increase for Hue angle (coloration) ($P<0.01$) was observed also in cowpeas and chickpeas over the entire range of irradiation doses.

From the above mentioned facts; it was clear that irradiation had a great influence on color attributes of certain kinds of legumes. These varieties were; lentils, kidney beans and chickpeas. Also heat and irradiation had a great influence on both lentils and lima beans soups. The other varieties of legumes had the ability to be stable in color during irradiation.

Table (5) showed the reflectance spectral data of the legumes under study and their soups. It seems in cowpeas,($p<0.01$) chickpeas,($p<0.05$) lentils soup; ($p<0.05$) that there were a dose reflectance relationship. The data showed a significant negatively correlation coefficient between the

irradiation doses and the reflectance over the wavelengths 400, 500, 600 and 700nm in cow peas and chickpeas. This could be attributed to the presence of certain types of carotenoids which might be oxidized during irradiation treatments. Also in the French beans soup, the data showed also a significant dose- reflectance (P<0.05) at 400 nm which may indicate that browning might occur during processing.

Table (4) Correlation coefficients, between CIE color measurements and changes in different irradiation doses (KGy*) of different legumes types and their soup powder.**

Legumes	L*	a*	b*	ΔE	H* (coloration)	C* (chroma)
Faba beans						
S.E.	0.832	0.136	0.452	0.785	0.813	0.461
R^2	0.666	0.356	0.069	0.616	0.194	0.076
Lentils						
S.E.	1.313	0.556	0.479	0.848	0.014	0.635-
R^2	0.442	0.812	0.899*	0.875-	0.594	0.887
French beans						
S.E.	0.651	0.126	0.345-	0.689	0.086	0.347
R^2	0.081	0.610	0.629	0.205	0.777	0.887
Cowpeas						
S.E.	0.186	0.079	0.317	0.282	0.0047	0.312
R^2	0.989**	0.988*	0.782	0.989**	0.988**	0.794
Chickpeas						
S.E.	0.0768	0.0438	0.264	0.249	0.001	0.25
R^2	0.2398	0.979**	0.879	0.905*	0.985**	0.900*
Faba beans soup						
S.E.	1.824	0.306	1.924	2.347	0.049	1.736
R^2	0.405	0.0027	0.145	0.0010	0.083	0.156
Lentils soup						
S.E.	0.322	0.241	0.439	0.132	0.0060	0.483
R^2	0.994*	0.904	0.1005	0.999*	0.971	0.0013
French beans soup						
S.E.	0.459	0.154	0.052	0.157	0.0078	0.032
R^2	0.945	0.972	0.997*	0.995*	0.957	0.999*
Cowpeas soup						
S.E.	1.612	0.429	0.474	1.669	0.783	0.609
R^2	0.033	0.296	0.505	0.000052	0.087	0.221
Chickpeas soup						
S.E.	0.708	0.302	0.741	1.669	0.0059	0.773
R^2	0.206	0.121	0.041	0.000051	0.230	0.048

S.E. standard error *** Significance at 5%.** **** significance at 1%.**
R^2: Correlation coefficients ***** the doses were at 0,1, 5, 10**

Table (5): Comparison of spectral data means of different varieties of legumes as related to different irradiation doses at 0,1, 5, and 10 KGy.

Spectral data	Dose (KGy)					
	0.0	1	5	10.0	S.E	R^2
Faba beans						
400	36.37	33.17	33.35	31.52	1.426	0.669
500	53.90	50.64	50.99	49.78	1.493	0.535
600	68.61	65.31	64.58	63.54	1.529	0.675
700	77.30	74.66	73.48	73.45	1.412	0.594
Lentils						
400	20.79	21.93	20.56	23.89	1.292	0.519
500	28.59	30.03	28.46	33.90	1.899	0.627
600	55.53	56.45	53.99	58.17	1.873	0.234
700	64.45	65.45	62.85	66.29	1.658	0.1279
French beans						
400	41.27	38.46	40.40	39.34	1.458	0.058
500	64.25	61.72	64.09	62.76	1.456	0.0085
600	73.50	71.55	73.86	73.36	1.170	0.1452
700	81.71	80.36	82.49	81.93	0.959	0.249
Cowpeas						
400	34.62	33.54	30.90	29.33	0.6296	0.9548*
500	54.15	53.18	50.21	47.69	0.413	0.987**
600	65.80	65.41	62.79	60.81	0.335	0.986**
700	73.86	73.75	71.73	70.17	0.254	0.986**
Chickpeas						
400	33.55	33.82	33.40	32.79	0.199	0.8613
460	38.20	38.61	38.71	39.95	0.288	0.903*
470	39.83	40.29	40.42	41.80	0.315	0.908*
480	40.91	41.39	41.57	43.08	0.331	0.917*
490	41.90	42.35	42.59	44.17	0.328	0.926*
500	45.68	46.22	46.45	47.97	0.323	0.928*
510	51.79	52.33	52.49	53.47	0.244	0.919*
600	71.71	71.88	71.73	71.41	0.126	0.727
700	81.01	81.34	80.82	80.76	0.211	0.566
Faba beans soups						
400	20.64	19.95	19.68	-	0.884	0.699
500	28.02	30.34	27.05	-	1.939	0.342
600	40.59	43.98	38.82	-	2.889	0.393
700	52.03	56.21	50.85	-	3.407	0.268
Lentils soups						
400	7.23	7.43	9.73	-	0.231	0.986
500	13.02	13.35	17.24	-	0.397	0.986
600	21.37	22.13	26.84	-	0.258	0.996*
700	31.55	32.68	37.46	-	0.0404	0.999*
French beans soups						
400	28.57	28.16	25.72	-	0.123	0.996*
500	62.06	52.07	46.87	-	0.809	0.964
600	67.49	67.72	63.83	-	0.742	0.942
700	75.68	76.69	74.16	-	1.0137	0.683
Cowpeas soups						
400	16.24	18.01	15.82	-	1.430	0.242
500	22.67	25.16	23.19	-	1.841	0.017
600	34.43	36.90	34.70	-	1.864	0.054
700	48.45	50.79	48.59	-	1.784	0.076
Chickpeas soups						
400	22.59	21.75	21.14	-	0.424	0.830
500	35.24	34.72	34.12	-	0.3836	0.012
600	61.39	58.86	59.58	-	1.665	0.193
700	71.40	68.72	69.98	-	1.849	0.049

S.E. Standard error — * : significance at 5%
** significance at 1% — R^2: Correlation coefficients

3.3 Sensory evaluation of the irradiated legumes and their soup powders.

3.3.1 At safe doses

From the results obtained in table (6); it was concluded that irradiation of legumes at doses up to 1 KGy for the purpose of insect disinfestation will not result in any changes in the organoleptic properties. (Delincee and Bognar 1993) came to the same conclusion. Gunha et al 1993 found also that sensory properties of the irradiated samples did not differ (P< 0.05) from the color in case of using a dose at 2 KGy.

3.3.2 At higher doses

Table (6) showed the sensory evaluation properties of the irradiated legumes under study. It was shown by most of the panelists that irradiation at 10 kGy was characterized by the offensive off flavor. The data also showed a strong correlation coefficient between irradiation doses and off flavor. It was significant in case of faba beans (P<0.05); lentils (P<0.05) and French beans (P<0.05). The changes in color characteristics was observed by the most of the panelists. The level of lightness was enhanced significantly (P<0.05) in case of lentils soup. French beans, French beans soups and chickpeas. The changes in visual quality was more pronounced by higher irradiation doses (P<0.01) in case of chickpea soups.

CONCLUSION

Irradiating legume seeds at 1 KGy which is the safe and appropriate dose for insect disinfestation induced an enhancement in the rate of water absorption and also it has a noticeable improvements in the softening of legumes seed which is hard to cook. When legumes under study were irradiated at doses more than the recommended dose (5, 10 KGy); the following changes were noticed:-

- The rate of water absorption was getting higher as a result of increasing radiation doses in all the studied legumes.
- Each type of legumes studied respond differently towards water absorption rate against cooking time at different irradiation doses. The effect was minimal in case of chickpeas and cowpeas and higher in case of French beans and lentils.
- Based on the color measurements studies (hunter lab studies); It was clear that irradiation had a great influence on certain varieties of legumes that contained a substantial amount of carotenoids pigments that might be oxidized during irradiation. These varieties were: lentils, cowpeas and chickpeas. The other varieties of legumes: faba beans, French beans had the ability to be stable in color during irradiation.
- The changes in the color characteristics and off flavor were greatly observed among the legume varieties by most of the panelists. All these changes could be of importance in establishing an irradiation parameters might be useful in identifying irradiated foods.

Table (6): Sensory evaluation properties of irradiated legumes and their soups.

	Dose (KGy)				
	0	**1.0**	**5.0**	**S.E**	**R^2**
Faba beans					
Off flavor	2.4	2.5	3.12	0.0339	0.996*
Saturation	4.1	5.2	5.2	0.679	0.429
Lightness	1.2	3.3	3.7	1.234	0.578
Visual Quality	5.30	5.21	5.30	0.0694	0.1071
Faba beans (Soup)					
Off flavor	1.7	3.12	3.70	0.787	0.708
Saturation	5.4	6.1	6.30	0.401	0.639
Lightness	6.2	6.3	6.4	0.046	0.898
Visual Quality	5.20	5.24	5.27	0.0200	0.837
Lentils					
Off flavor	1.1	1.6	2.9	0.108	0.993*
Saturation	4.3	4.3	4.4	0.015	0.969
Lightness	5.0	5.2	5.3	0.108	0.750
Visual Quality	6.10	6.20	6.15	0.069	0.036
Lentils (soups)					
Off flavor	1.2	1.8	1.88	0.358	0.536
Saturation	5.3	4.1	5.7	0.987	0.296
Lightness	7	7.2	7.8	0.0308	0.998*
Visual Quality	5.10	5.15	5.70	0.054	0.986
French beans					
Off flavor	2.1	2.2	2.7	0.0154	0.998*
Saturation	3.3	3.4	3.7	0.0154	0.998*
Lightness	1.3	1.4	2	0.0309	0.996*
Visual Quality	7.20	7.30	7.10	0.093	0.571
French beans (soups)					
Off flavor	1.3	2.4	2.9	0.602	0.729
Saturation	3.8	3.9	4.2	0.0154	0.997*
Lightness	1.5	1.6	2.2	0.031	0.998**
Visual Quality	8.30	8.25	8.34	0.045	0.508
Cowpeas (soups)					
Off flavor	1.70	1.74	1.80	0.015	0.953
Saturation	7.4	7.50	7.42	0.074	0.020
Lightness	6.3	6.25	6.30	0.039	0.1070
Visual Quality	4.20	4.30	4.25	0.069	0.036
Cowpeas					
Off flavor	1.4	1.8	1.9	0.231	0.647
Saturation	3.3	4.1	5.2	0.321	0.970
Lightness	2.2	3.3	4.1	0.617	0.812
Visual Quality	7.10	7.15	7.30	0.0078	0.997*
Chickpeas					
Off flavor	1.2	2.4	2.5	0.725	0.497
Saturation	4.7	4.2	2.8	0.0926	0.996*
Lightness	5.0	4.5	3.0	0.0926	0.994*
Visual Quality	7.40	7.13	7.30	0.193	0.001
Chickpeas (soups)					
Off flavor	1.0	2.1	2.2	0.666	0.50
Saturation	5.4	5.5	4.10	0.278	0.93
Lightness	4.3	5.4	4.17	0.869	0.174
Visual Quality	6.30	6.40	6.66	0.022	0.993**

0 : Not noticeable 1: Trace- not sure 2: Faint
3: Slight 4: Mild 5: Moderate
6: Definite 7: Strong 8: Very strong
S.E. Standard error * : significance at 5% ** significance at 1%
R^2: correlation coefficient

ACKNOWLEDGMENT

The authors wish to express their thanks to Prof. Dr. A.A. Mahmoud, Head of food irradiation Dept. at the National Radiation Research center for his kind help through irradiating our research samples.

REFERENCES

Aclemente, A. Vioque, R.S. Vioque, J. Bautista, J. and Millan F. (1998). Effect of processing on water absorption and softening kinetics in chickpeas (cicer arietinum l.) seeds J. Sci. Food Agric 78, 169-174.

Antunes, P.L. and Sgarbieri, V.C. (1979). Influence of time and condition of storage on technological and nutritional properties of dry bean (phaseolus vulgaris L.) var. Rosinha G2. J. Food Sci. 44, 1703- 1706.

Anzaldua-Morales, A. Qunitero, A. and Balandan, R. (1996). Kinetics of thermal softening in six legumes during cooking J. Food Sci. 61, 167-170.

Aquirre Terrazaz, M. Anzaldua-Morlas, A. Qunitero, A. Gastelum, G. and Torres J. (1992). Effect of soaking and cooking on the texture of beans (*Phaseolus vulgaris* Rev. Esp. Cion. Tech Ali 32, 401-406.

Carvalho, M. R.B.; Da Silva Rodriques, M.A.A.P., Tavares, D. Q. McGinnis, J. Sgarbieri, V.C. Presqui, and Agro pecu. Bras. (1991). 26: 1663-1672.

Delincee, H. and Bognar, A. (1993). Effect of ionizing radiation on the nutritive value of legumes. Federation of European-chemical societies Part II pp 367-371.

Diehl, J.F. (1991).Nutritional effects of combining irradiation with other treatments. Food Control, 2(1) 20-5.

Diop, Y.M. Marchioni, E. Da. D. and Hasselamann, C. (1997). Radiation disinfestation of cowpea seeds contaminated by callosobruchus maculatus. J. of food processing and preservation 21 (1) 69-81.

Drapper, N.R. and Smith, H. (1981). Applied Regression analysis 2nd ed. John Wiley & Sons, N.Y.

El-Saadany, R.M.A. (1972). Effect of gamma irradiation on some components of wheat flour. Ph. D. Thesis, Faculty of Agriculture. Ain Shams University. Cairo.

Francis. F.J. and Glydesdale, F.M. (1975). Food Colorimetry: Theory and Applications. AVI Publishing company. Inc. Westport, CT.

Garcia, E. Lajolo, F.M. and Swanson, B.G. (1993) A comparative study of normal and hard to cook Brazilian common bean (*Phaseolus vulgaris:* Ultrastructural and histochemical aspects. Food structure 12(2) 147-154.

Gunha, M.F. Sgarbieri, V.C. and Damasio, M.H. (1993). Effects of pretreatment with Gamma Rays or Microwaves on storage stability of Dry Beans. J. Agric. Food. Chem. 41, 1710-1715.

Hentges, D. Weaver, C. and Nilesen S.S. (1991). Changes of selected physical and chemical components in the development of the hard to cook bean defect. J. Food Sci. 56, 436-442.

Hossain, M.M. (1994). Establishment of a gamma irradiation facility of Gammatech Ltd in chittagong Bangladesh. Food irradiation Newsletter, 18 (1): 64.

International project in the field of food irradiation news (1980). In "Food Irradiation Information" Vol 10, (Ed). Potter W.T., Elias P.S. and Gottschalk H.M. P 46, Karlsruhe. Germany.

Jun Kang, Il and Woo Byun, Myung (1996). Water absorption, cooking time properties and cell structure of gamma irradiated soybeans. J. of the korean facility of food science and nutrition 25(5) 796-803.

Khattak, A. B. and klopfenstein, C.F. (1989). Effects of gamma irradiation on the nutritional quality of grains and legumes. I. Stability of niacin, thiamin and riboflavin. Cereal Chem. 66(3) 169-76.

Mahrous, S.R. (1983) Effect of gamma irradiation on physico-chemical properties and aflatoxin contamination of wheat, dough and bread from M.Sc. Thesis Food Sci. and Technol. Dep. Faculty of Agriculture, Cairo university. Giza.

Majia, E.G. Arch. Latinoam Nutr. (1982). 32, 258-274.

Mancini, F.J. Takaki, K. and Nascimento, Cr. (1995). Total phenolics compounds and cooking time of irradiated beans. IFT Annual meeting.

Rao, V.S. and Vakil, U.V. (1985). Effect of Gamma radiation on cooking quality and sensory Attributes of four legumes J. food Sci. 50 372-376.

Roy, H.K. and Prasad, H.H. (1993) Gamma radiation in the control of important storage pests of three grain legumes. J. of food Sci. and tech.. India 30(4) 274-276.

SAS Institute Inc (1985). "SAS" user Guide, statistics 5th ed. SAS Institute Inc cary N.C.

Stone, H. Sidel, J. Oliver, B. Woolsey, A. and singleton, R. C. (1974). Sensory evaluation by quantitative descriptive analysis. Food Tech. 28(11), 24-34.

Streenivassen, A. (1974). Compositional and quality changes in some irradiated foods, in improvement of food quality by irradiation, Proceedings of a panel, Vienna June 1973. International Atomic Energy Agency, Vienna pp. 129-55.

Van Bourne, J.P. (1989). Applications of chemical kinetic theory to the rate of thermal softening of vegetable tissue. J. Texture studies 10 1-23.

Williams, P. Nakoul, H. and Singh, K. (1983). Relationship between cooking time and some physical properties in chickpeas (cicer arietinum). J. Sci. Food Agric. 34, 492-496.

التغيرات التى تحدث فى الصفات الطبيعية للأنواع المختلفة من البقوليات المشععة ومسحوق الشوربة الناتجة منها.

وفاء حسين أمام- السيد عبد البر سالم – هشام أحمد محرم
قسم الصناعات الغذائية والألبان- المركز القومى للبحوث –الدقى -القاهرة

تم فى هذا البحث دراسة تأثير الأشعاع على بعض الصفات الطبيعية – الكيماوية فى خمسة من انواع البقوليات المصرية المختلفة وهى الفول-العدس- الفاصوليا –الحمص- اللوبيا والأنواع المختلفة من مسحوق الشوربة الناتجة منها وقد تم دراسة هذا التأثير عند مستويين من الأشعاع المستوى الأول عند الجرعة 1 كيلوجراى وهى تعتبر جرعة آمنة ولها تأثير حافظ ضد مهاجمة الحشرات وأستخدمت كذلك جرعات عالية من 5، 10 كيلوجراى وذلك بهدف التعرف على دلائل لعملية الأشعاع .

النتائج التى تم التحصل عليها عند جرعة 1 كيلوجراى قد اوضحت أن هناك اتجاه فى الزيادة فى معدل امتصاص الماء فى كل انواع البقوليات تحت الدراسة كذلك حدثت ليونة Softness فى هذه البقوليات وبالتالى حسنت من درجة الطبخ فى هذه الأنواع من الحبوب.

اظهرت الدراسة ان درجة أمتصاص الماء والتغيرات التى تحدث فى قياسات اللون كانت من ضمن العوامل التى يمكن ربطها بالجرعات الأشعاعية المختلفة ، التغير فى اللون لهذه الأنواع المختلفة من البقوليات يعتمد بدرجة كبيرة على الصنف. كان هناك تأثر كبير فى المقاييس المختلفة للون (a*,L*,b*) بالنسبة للعدس – الحمص – اللوبيا الأنواع الأخرى مثل الفول والفاصوليا لم تظهر أى أختلاف فى اللون نتيجة لزيادة جرعة الأشعاع.

أوضحت كذلك الدراسات الحسية للأنواع المختلفة للبقوليات المعاملة بالأشعاع وكذلك انواع الشوربة الناتجة منهم أن هناك تغيرات فى اللون والرائحة قد لوحظت فى معظم المحكمين.