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EFFECT OF GAMMA IRRADIATION ON COOKING TIME AND ASSOCIATED PHYSICOCHEMICAL PROPERTIES OF TWO LEGUMES

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Effect of gamma irradiation (0.25-5.00 kGy) on physical properties (seed size and density), water uptake (swelling and hydration capacities and indices), cooking time and phytic acid content was studied for five varieties each of chickpea and mungbean . Upto 5 kGy irradiation had no significant effect on physical and water uptake properties of these legumes, but cooking time and phytic acid content were drastically reduced. Irradiation caused more reduction in cooking time of chickpea than of mungbeans.

Key words: Gamma irradiation, Legumes, Physicochemical properties.

Introduction

Legumes being rich in protein and other essential nutrients are very important from nutritional point of view [1,2]. Proteins from legumes are of superior quality among plant sources and hence, can prove a good substitute for costly proteins of animal origin in the developing countries [3]. When blended in proper proportions these proteins can complement cereal proteins in terms of several essential amino acids [4]. Inclusion of legumes in the common man's diet can thus help in controlling protein calories malnutrition.

Prolonged cooking generally required for legumes makes their utilization uneconomical and cumbersome. Moreover, excessive cooking of legumes results in protein losses and in lower availability of certain essential amino acids [5]. Cooking time can be reduced by addition of alkaline chemicals. However, that adversely affects the overall acceptability of the cooked samples [6] and produces unnatural cross-linked amino acids (e.g. lysinoalanine) which are indigestible and have nephrotoxic effects on rats [7]. Gamma irradiation has been reported to reduce cooking time in some legumes [8]. In this paper the effects of different doses of gamma irradiation on water uptake properties and cooking time of five varieties of chickpea and mungbean have been reported.

Materials and Methods

Seeds of five varieties each of mungbean (NM-13-1, NM-19-19, NM-121-25, S-51 and S-54) and chickpea (CM-72, CM-1913, CM-1918, C-141 and 6153) were obtained from Mutation Breeding Division of Nuclear Institute for Food and Agriculture (NIFA) Peshawar. All varieties were grown during 1987-88 at the same location under standard agronomic practices. Seeds of each variety were cleaned and packaged into six seperate polyethylene bags seperately to be irradiated at doses of 0,0.25, 0.50, 1.00, 2.5 and 5.00 kGy without vaccum at room temperature (30°) in a gamma researcher Co-60 radiation source. Dose rate at the time of irradiation was 5.2066 kGy per hr. Evaluation of the irradiated as well as control samples for various parameters was started a day after irradiation.

Physical measurements. The procedure of Williams *et al.* [9] was followed for physical measurements. Fifty seeds were counted in triplicate and weighed. The weight per seed was recorded as the mean weight of fifty seeds. Seed volume was determined by transfering these 50 seeds into a 50 ml measuring cylinder and adding 25 ml distilled water to it. The gain in volume divided by 50 gave the volume per seed. Hydration capacity was recorded as the gain in weight after overnight soaking in distilled water. Hydration index was calculated as the hydration capacity divided by original seed weight. The swelling capacity was determined as the gain in volume after overnight soaking in distilled water. Swelling index was calculated as swelling capacity divided by original seed volume.

Cooking time. Procedure of williams *et. al.* [9] was adopted for the determination of cooking time of legumes except that 25g of sample was soaked for 2 hr in case of mungbean, and for 16 hr in case of chickpea. Distilled water instead of tap water was used for cooking. While being cooked, samples were drawn at definite intervals (2 min.) and evaluated by a panel of judges to ensure uniform cooking and softness.

Phytic acid. A sensitive method for the rapid determination of phytate in cereals and cereal products was adopted for the determination of phytic acid content [10]. The sample extract (with 0.2 N HCL) was heated with an acidic iron III solution of known iron content. The decrease in iron content (determined colorimetrically with 2,2 bipyridine) in the supernatent was the measure for phytic acid content.

Statistical analysis. All the data were analysed by the analysis of variance with least significant difference (LSD) to determine significance of differences between treatments and varietal means [11].

Results and Discussion

Chickpea. Table 1 shows the effect of gamma irradiation and genotype on the physical, water uptake and cooking

TABLE 1. EFFECT OF IRRADIATION AND GENOTYPE ON MEAN VALUES OF PHYSICAL, WATER UPTAKE AND COOKING PROPERTIES OF CHICKPEA.

	Radiation doses (kGy)							Varieties					
	0	0.25	0.50	1.00	2.50	5.00	L.S.D	CM-72	CM-1913	CM-1918	C-141	6153	LSD
Moisture (%)	9.73	9.89	9.94	9.91	9.91	9.46	N.S	9.93	9.86	9.96	9.97	9.45	N.S
Seed weight(g)	0.2156	0.2132	0.2187	0.2149	0.2146	0.2179	N.S	0.1949	0.1971	0.1872	0.2460	0.2539	N.S
Seed volume(ml)	0.1457	0.1480	0.1526	0.1493	0.1480	0.1507	N.S	0.1347	0.1355	0.1289	0.1700	0.1761	N.S
Density(g/ml)	1.48	1.44	1.44	1.43	1.45	1.45	N.S	1.45	1.46	1.45	1.45	1.43	N.S
Swelling capacity(ml/seed)	0.2000	0.1920	0.1964	0.1880	0.1910	0.1967	N.S	0.1903	0.1689	0.1625	0.2244	0.2239	0.028
Swelling index (ml/ml)	1.37	1.30	1.30	1.28	1.30	1.31	N.S	1.41	1.27	1.27	1.32	1.27	N.S
Hydration capacity(g/seed)	0.1842	0.1851	0.1845	0.1830	0.1817	0.1909	N.S	0.1698	0.1687	0.1569	0.2200	0.2089	0.0136
Hydration Index (g/g)	0.8518	0.8696	0.8442	0.8609	0.8465	0.8739	N.S	0.8714	0.8558	0.8378	0.8962	0.8278	0.0496
Cooking time (min.)	31.8	25.5	24.4	16.8	13.3	9.6	5.81	13.53	29.08	12.66	24.33	19.17	5.306

properties of chickpea. Gamma irradiation did not alter significantly the moisture content, seed weight, seed volume, density, hydration capacity, hydration index, swelling capacity and swelling index. However, effect of different doses of gamma irradiation was highly significant (P<0.01) on cooking time. Highest mean cooking time of 31.8 min. was recorded for control samples of all cultivars which was reduced by 70.9% to 9.6 min. with 5.00 kGy doses (Fig 1). Genotypic

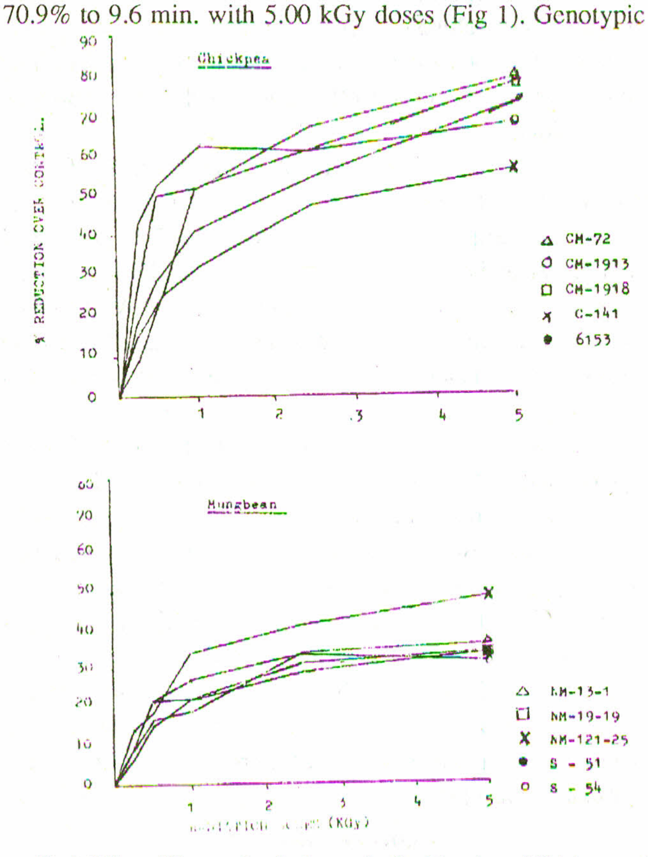

Fig 1. Effect of Gamma Irradiation on the Cooking time of Chickpea and Mungbean varieties.

differences with respect to moisture content, seed weight, seed volume, density, and swelling index were non-significant, whereas values of swelling capacity, hydration capacity and index and cooking time were significantly (P<0.01) different for different varieties. These values ranged from 0.1625 to 0.2244, 0.1569 to 0.22, 0.8278 to 0.8962 and 29.08 to 12.66, respectively among various chickpea genotypes.

Mungbean. As in case of chickpea, none of the physicochemical properties of mungbean was affected by any dose of irradiation applied (Table 2). Genotypic differences in moisture content, seed weight, seed volume, swelling capacity and hydration capacity were highly significant (P<0.01) whereas those for density, swelling index and hydration index were statistically non-significant. Maximum moisture content (11.22%), seed weight (0.0564g), seed volume (0.0442 ml/seed), density (1.5g/ml), swelling capacity (0.067ml uptake/seed), swelling index (1.61ml uptake/g), hydration capacity (0.063g uptake/seed) and hydration index (1.27 uptake/g) were observed in varieties NM-13-1, S-51, S-54, NM-121-25, S-51, NM-13-1, S-51 and S-54 respectively. On the whole, the varieties S-51 and S-54 were hydrated to higher levels whereas mutant/varieties of NIAB were relatively less hydrated.

Irradiation had highly significant (P<0.01) effect on cooking time (Table 2). Longest cooking time (21.3 min.) was recorded for control samples and it was gradually reduced with increasing irradiation doses. Shortest cooking time (13.70 min.) was recorded for samples irradiated at 5.00 kGy dose. However, it can be seen from Figure that most of the reduction in cooking time over control in all the cultivars was seen with lower irradiation doses. At 1.00 kGy dose 24.85% reduction was observed. At 2.50 kGy dose the reduction was 33.90%, while at 5.00 kGy dose the average reduction in cooking time

TABLE 2. EFFECT OF IRRADIATION AND GENOTYPE ON PHYSICAL, WATER UPTAKE, COOKING PROPERTIES AND PHYTIC ACID CONTENT OF MUNGBEAN.

	Radiation doses (kGy)							Varieties					
	0	0.25	0.50	1.00	2.50	5.00	L.S.D	13-1	19-19	S-54	121-25	S-51	LSD
Moisture (%)	10.64	10.50	10.54	10.57	10.54	10.49	NS	11.22	10.29	10.55	10.79	0.94	0.2427
Weight/seed(g)	0.0455	0.0459	0.0468	0.0451	0.0459	0.0532	NS	0.0402	0.0364	0.0551	0.0474	0.0564	0.0165
Volume/seed(ml)	0.0344	0.0358	0.0362	0.0350	0.0362	0.0354	NS	0.0310	0.0282	0.0442	0.0320	0.0422	0.0044
Density g/ml	1.32	1.28	1.29	1.29	1.27	1.56	NS	1.30	1.30	1.25	1.50	1.33	NS
Swelling capacity ml/seed	0.053	0.054	0.055	0.054	0.054	0.055	NS	0.050	0.044	0.063	0.046	0.067	0.0060
Swelling Index ml/ml	1.53	1.50	1.53	1.53	1.51	1.58	NS	1.61	1.54	1.44	1.46	1.60	NS
Hydration capacity g/seed	0.049	0.050	0.051	0.050	0.052	0.046	NS	0.047	0.04	0.06	0.039	0.063	0.01
Hydration Index g/g	1.08	1.10	1.10	1.10	1.14	1.00	NS	1.18	1.10	1.27	0.91	1.12	NS
Cooking time (min.)	21.30	19.20	16.40	16.00	14.35	13.70	1.13	16.08	15.79	18.67	13.08	21.33	1.16
Phytic acid (mg/100g)	232.50	206.40	205.30	193.50	177.80	182.40	30.86	169.64	211.96	233.38	227.06	156.26	27.60

rose only to 37.77%. While comparing data in figure, more % reduction in cooking time due to irradiation was observed in chickpea than in mungbean. Reduction in cooking time due to irradiation of soybean [12] broad beans [13] mungbean, lentil, horsebeans and chickpea [8] has been reported in literature.

The amount of 0.2 N HCl-extractable phytic acid in mungbeans was also significantly ($p<0.01$) reduced with irradiation. Maximum phytic acid content (232.50 mg/100g) was observed in control samples and it was reduced to 182.40 mg/100g with 5.00 kGy dose.

Differences in cooking time and phytic acid content among varieties were also significant ($p<0.01$). Maximum cooking time (21.33 min.) and phytic acid content (233.38 mg/100g) were recorded in varieties S-51 and S-54 respectively while minimum values (13.08 min. and 156.26 mg/100g respectively) were observed in varieties NM-121-25 and S-51, respectively.

The water obsorption ratio and capacity of beans (legumes) have been shown to be affected by heredity, cultivation conditions, storage and soaking conditions. Hydration process greatly involves starch and proteins and is influenced by cellular structure of bean seeds [14]. Irradiation of legumes results in increased solubility of legume flour and starch [15] alongwith an increase in the *in vitro* proteolysis and an increase in free amino acids in soluble proteins [16]. Present results regarding the influence of gamma irradiation on water uptake properties of legumes are in agreement with those of Rao and Vakil [8] who did not find any significant difference in the hydration capacity of control and less than 10 kGy irradiated legumes samples.

Besides reduction in cooking time and phytic acid content, irradiation of legumes has been reported to improve its nutritive value [17-18]. Other added benefits of legume irradiation could be its disinfestation [19], and reduction in flatulance causing oligosaccharids [20], trypsin and chymotrypsin inhibitors [21].

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