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Quality Assessment and Consumers Acceptability Studies of Newly Evolved Mungbean Genotypes (*Vigna radiata* L.)

Amal Badshah Khattak, Nizakat Bibi and Aurangzeb
Nuclear Institute for Food and Agriculture, Tarnab, Peshawar, Pakistan

Abstract: Quality and consumers acceptability studies of 9 newly developed genotypes and three commercial varieties of mungbean were carried. Maximum protein content were noted in genotype C1/94-4-19 (23.69%) and NM-3 (23.25%) and minimum in Ramzan and DM-2 (20.98%). Highest moisture content was noted for NM-3 (11.14%) and lowest for DM-2. Mineral concentration was highest in DM-2 (0.0207%) and lowest in NCM-209 (0.169%). Genotypes DM-2, C1/94-4-19 and NFM-12-12 have the highest content of methanol extractable, water extractable and phytic acid, respectively. Swelling capacity and index and hydration capacity and index were maximum for the genotype 99-CMG-058 and minimum for NM-92. Least time for cooking was taken by Ramzan (14 min) and longest time by DM-2 (26.5 min). Smallest number of hard seeds (un-cook able) was found in 99-CMG-058 and M-2 while highest number of hard seed was noted in C1/94-4-19 (108) and NM-92 (101). Density was maximum for NM-98 and minimum for VC-3960 (A89). Impact of genotype was significant for all the parameters studied.

Key words: Mungbean, genotype, nutrient, anti-nutrient, cooking properties

INTRODUCTION

Mungbean (*Vigna radiate* L.) is one of the important pulse crops grown and consumed in Pakistan. It is a native of India-Burma and is cultivated extensively in Asia. It has been grown in India since ancient times. Its short duration, low water requirement, wide adaptability to fit in different crop rotations and varying cropping patterns can contribute to sustainability in increasing the farm productivity per unit area. It is still widely grown in Southeast Asia, Africa, South America and Australia. It was apparently grown in the United States as early as 1835 as the Chickasaw pea. It is also referred to as green gram, golden gram and chop suey bean. Mungbeans are grown widely for use as a human food (as dry beans or fresh sprouts), but can be used as a green manure crop and as forage for livestock.

Mungbean serves as vital source of vegetable protein (19.1 to 28.3%), minerals (0.18 to 0.21%) and vitamins particularly in developing countries. Mungbean seeds are sprouted for fresh use or canned for shipment to restaurants. Sprouts are high in protein (21-28%), calcium, phosphorus and certain vitamins. Apart from being a valuable source of protein, consumption of legumes has also been linked to reduced risk of diabetes and obesity (Geil and Anderson, 1994; Venkateswaran *et al*., 2002) coronary heart disease (Anderson *et al*., 1984; Bazzano, 2001) colon cancer (Hughes *et al*., 1997; Hangen and Bennink, 2002) and gastrointestinal disorders, (Bourdon *et al*., 2001; Kolonel *et al*., 2000). Consumption of legumes may also have a protective effect against prostate cancer in humans (Kolonel *et al*., 2000). The phenolic compounds present in these legumes are known to exhibit strong antioxidant, anti-mutagenic and anti-genotoxic activities (Badshah *et al*., 1991).

Corresponding Author: Amal Badshah Khattak, Nuclear Institute for Food and Agriculture, Tarnab, Peshawar, Pakistan
Tel: 009192-2964060-2 Fax: 009192-2964059

On the other hand anti-nutritional properties of phytic acid and polyphenols have been a concern for the nutritionists. Phytic acid binds minerals, thereby rendering them unavailable for metabolism. Phenolic compounds or their oxidized products form complexes with essential amino acids, enzymes and other proteins, thus lowering their nutritional value (Shahidi and Naczk, 1992) and protein digestibility (Mitaru *et al*., 1984). These anti-nutrients can be fully or partially removed by processing (Singh, 1988; Harmuth-Hoene *et al*., 1987; Ibrahim *et al*., 2002).

This study was undertaken to evaluate newly developed genotypes for quality and consumers acceptability characteristics to provide significant feed back to breeders in the development of the most suitable varieties.

MATERIALS AND METHODS

Newly evolved mungbean genotypes were obtained from the Breeding Division of the Nuclear Institute of Food and Agriculture, Tarnab, Pakistan. Moisture, protein and mineral concentration were determined by the standard methods of AOAC (1984) i.e., methods number 10-231, 10-177 and 14-063, respectively. Physical properties and cooking time were determined by methods reported by Badashah *et al*. (1987, 2003 and 2005).

Extraction and Assay of Total Phenols (%)

Weighed amount of sample was extracted with methanol (6 mL mg^{-1}) for 30 min in a screwcapped test tube. After centrifugation, the residue was re-extracted with methanol and the two methanol extracts were combined for methanol extractable total phenols determination. Aqueous extract for each sample was prepared by boiling 0.5 g sample in 50 mL distilled water for half an hour as reported by Bibi *et al*. (2001). Total phenols were determined spectrophotometrically using folin ciocalteaus phenol reagent which consists of 2.5% sodium molybdate and 19% sodium tungstate (Senter *et al*., 1989).

Phytic Acid (%)

Phytic acid contents were determined by the method of Haug and Lantzsch (1983). 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 supernatant was the measure of the phytate phosphorus.

Proximate Composition

Moisture content (%) were determined by oven drying method (AOAC, 1984). Grain protein content (%) was assayed by micro-Kjeldahl method as outlined in AOAC (1984). The conversion factor used to convert the Kjeldahl nitrogen to (%) protein was 6.25. Ash content (%) was determined after incinerating the whole-wheat ground flour samples for 16 h at 575°C (AOAC, 1984).

Physical and Water Uptake Properties of Seeds

Density (g mL^{-1}) is the ratio between weight and volume of seed (weight of 100 seed/ volume of 100 seed). Hydration capacity (g $seed^{-1}$) is the gain in weight of a seed after 24 h soaking (weight of 100 seeds after 24 h soaking-weight of 100 seeds before soaking)/100. Hydration index is the ratio between hydration capacity and average seed weight (Hydration capacity/seed size). Swelling capacity (mL $seed^{-1}$) is the gain in volume of a seed after 24 h soaking (volume of 100 seeds after 24 h soaking–volume of 100 seeds before soaking)/100. Swelling index is the ratio between swelling capacity and volume of the seed (swelling capacity/seed volume). The parameters relating to the water uptake properties were determined as reported by Badshah *et al*. (2003).

Cooking Indices

Cooking time (min) was determined (Badshah *et al*., 2003) by placing 25 g of seed in boiling water. Cooking was checked by pressing the seeds between thumb and finger after 10 min boiling and continued at 2 min interval. Cooking is complete when 80-100% of seeds become soft. Another quality parameter of grains related to cooking is the number of hard and soft seed which were determined by cooking thousand seeds for half an hour and then sorted for uncooked seed. The number was counted and reported as hard seeds/1000 and the remaining as soft seeds/1000.

Statistical Analysis

Statistical analysis was conducted for each of the measured traits by analysis of variance (ANOVA) using Completely Randomized Factorial Design. The means were separated by Duncan Multiple Range test (DMR) using software SAS (1996).

RESULTS AND DISCUSSION

Leguminous seeds constitute one of the richest and cheapest sources of proteins and are consequently becoming an important part of the people diet in many parts of the world. Impact of genotype on all the three parameters was statistically significant (Table 1). Moisture content was maximum in the genotype NM-3 with the value of 11.14%. DM-2 contain the minimum moisture (8.30%) followed by NCM-209 (9.77%), NM-98 (8.59%). Protein content ranged between 20.98 (commercial variety Ramzan) and 23.69% (C1/94-4-19) among the mungbean genotypes. Mineral concentration varied between 0.181% (C1/94-4-19), 0.169 (NCM-209) and 0.207% (DM-2). Variation in protein and ash (mineral concentration) occur among and with in seed lots. Yohe *et al*. (1971) evaluated 313 accessions at Columbia, Missouri, that included both adapted and un-adapted accessions, the accessions having originated in 18 countries. The protein range was 19.1 to 28.3% with the mean of 24%. The high protein strains tended to be late flowering, small seeded and low yielding. Bhadra *et al*. (1987) also found high protein cultivars to be small seeded and low yielding. By contrast, Trung and Yoshida (1982) reported a positive association of seed size and protein content. Mungbean seeds are good sources of minerals in the diet, being particularly rich in calcium, iron and phosphorous. Tannins (polyphenols) present in food legumes reduce the digestibility of dietary proteins. Variations in methanol extractable polyphenols were not significant in most of the genotype except DM-2 (having maximum) and NM-3 (having minimum) where the differences were highly significant (Table 2). Impact of genotype on water extractable polyphenols was also significant. Genotype C1/94-4-19 has the maximum content of water extractable polyphenols while genotype 99-CMG-058 has the minimum. Phytic acid, which is negatively correlated with *in vitro* protein digestibility, varies among legume species and among the varieties within a single legume (Chitra *et al*., 1995). Variations in phytic acid content among mungbean genotype were significant ($p<0.05$). Lowest values for phytic acid were noted in NM-98 (expected future variety) followed by NM-92 and NM-3. Kataria *et al*. (1989) reported that phytic acid, saponin and polyphenol contents in grains of various varieties of black gram (*Vigna mungo*) Mung bean (*Vigna radiata* L.) amphidiploids ranged from 697-750, 2746-2972 and 702-783 mg 100^{-1} g, respectively. Water uptake behavior of legume seed is of particular importance from the consumer point of view (Table 3). Significant differences in water uptake behavior among all the mungbean genotypes were observed. Genotype 99-CMG-058 was noted to have maximum swelling capacity (0.028 mL), swelling index (0.3864), hydration capacity (0.033 g) and hydration index (0.631) followed by genotype NM-3. Lowest values for swelling capacity, swelling index, hydration capacity and hydration index were recorded for NM-92.

Table 1: Effect of genotype on protein, moisture and ash content of mungbean

Cultivars	Moisture (%)	Protein (%)	Ash (%)
VC 3960 (A89)	9.18bc	21.76bc	0.1763i
NM-98	8.59bc	21.59bcd	0.1696j
NCM-209	9.77b	21.06cd	0.1690k
99-CMG-058	9.21bc	21.68bcd	0.1817g
NM-3	11.14a	23.25a	0.1855e
C1/94-4-19	9.28bc	23.69a	0.1810g
DM-2	8.30c	20.98d	0.2070a
M-1	9.10bc	22.20b	0.1921b
M-2	9.35bc	22.11b	0.1902c
NFM-12-12	8.68bc	21.15cd	0.1796h
NM-92	8.65bc	22.29b	0.1891d
Ramzan	8.64bc	20.98d	0.1850f

Values in each column followed by different letter(s) are significantly different ($p<0.05$)

Table 2: Polyphenol and phytic acid content of mungbean genotype

Genotypes	Methanol extractable Phenols (%)	Water extractable Phenols (%)	Phytic acid (%)
VC 3960 (A89)	0.084ab	0.158c	1.177d
NM-98	0.082b	0.150cd	0.798g
NCM-209	0.083ab	0.175a	1.121e
99-CMG-058	0.082b	0.144d	1.095ef
NM-3	0.079bc	0.163b	1.037f
C1/94-4-19	0.080bc	0.180a	1.277b
DM-2	0.089a	0.152cd	1.140cd
M-1	0.082b	0.173a	1.254bc
M-2	0.085ab	0.149d	1.246c
NFM-12-12	0.087a	0.171a	1.385a
NM-92	0.084ab	0.169ab	1.034f
Ramzan	0.085ab	0.162b	1.303ab

Values in each column followed by different letter(s) are significantly different ($p<0.05$)

Table 3: Effect of genotype on water uptake properties of mungbean

Cultivars	Density	Swelling capacity	Swelling index	Hydration capacity	Hydration index
VC 3960 (A89)	1.009g	0.005f	0.125d	0.010f	0.285de
NM-98	1.198a	0.004g	0.121d	0.004g	0.020f
NCM-209	1.047fg	0.009d	0.267b	0.010f	0.374bcd
99-CMG-058	1.150abcd	0.028a	0.3864a	0.033a	0.631a
NM-3	1.053efg	0.015b	0.250bc	0.021b	0.450b
C1/94-4-19	1.170ab	0.015b	0.250bc	0.020c	0.317cde
DM-2	1.135bcd	0.009d	0.214bc	0.012e	0.319cde
M-1	1.102def	0.011c	0.265b	0.013d	0.385bcd
M-2	1.055efg	0.009d	0.233bc	0.012de	0.390bc
NFM-12-12	1.109cde	0.006e	0.127d	0.010f	0.235e
NM-92	1.163abc	0.003h	0.094d	0.004g	0.126f
Ramzan	1.134bcd	0.010c	0.204c	0.012e	0.265e

Values in each column followed by different letter(s) are significantly different ($p<0.05$)

Maximum density was noted in genotype NM-98 (1.198 g) and minimum for VC 3960 (A89). Aurangzeb *et al*. (1988) while working on 15 mungbean genotypes, reported swelling capacity and index and hydration capacity and index with in the range of 0.019-0.04 mL and 0.66-1.67, 0.022-0.03 g and 0.6329-0.9212, respectively. According to them, the density ranged between 0.985 and 1.498 g.

Cooking time and numbers of hard and soft seeds of legumes are of prime importance to the consumers. Hard seeds do not cook even after prolong cooking and hence exhibit eating problem. Mungbeans are normally cooked in combination with rice in the northern hilly areas of Pakistan and the farmers of that area requested the breeders of our Institute to develop varieties with least number of hard seed. Variety Ramazan took lowest time for cooking (14 min) followed by NM92 (15 min) and VC 3960 (16.5 min). Smallest number of hard seed (8) and highest number of soft seed (992) were observed in 99-CMG-058 and highest number of hard seed (108) and lowest number of soft seed (892) were found in C1/94-4-19 (Table 4). Variety Ramzan and genotype M-2 ranked 2nd for having smaller

Table 4: Effect of genotype on cooking properties of mungbean

Cultivars	Cooking time (min)	HS*/1000 (uncooked)	SS*/1000 (cooked)
VC 3960 (A89)	16.5g	37d	963d
NM-98	19.0f	79c	921e
NCM-209	20.0ef	4i	996a
99-CMG-058	21.0de	8h	992b
NM-3	25.0ab	29e	971c
C1/94-4-19	22.0cd	108a	892f
DM-2	26.5a	2 I	998a
M-1	23.5bc	11g	989bc
M-2	20.0ef	9gh	991b
NFM-12-12	20.0ef	22f	978c
NM-92	15.0gh	101b	899f
Ramzan	14.0h	9gh	991b

Values in each column followed by different letter(s) are significantly different ($p<0.05$), *HS = Hard Seeds *SS = Soft Seeds

number of hard and greater number of soft seed. Hard seed do not cook even after prolong heating. Aurangzeb *et al*. (1988) reported cooking time of 15 mungbean genotypes that ranged between 20 and 24 min. It is clear from the Table 4 that cooking of almost 50% genotypes occurred with in 22 min. Cooking time of between 20-30% genotypes occurred in above 22 min while about 20% genotype cooked in 18 min. The most desirable genotypes (from the consumer's point of view) that cooked in 14 min were less than 10%. Mechanisms including the hard-to-cook phenomenon which results in the failure of cotyledon cells to separate even under prolonged cooking are poorly understood (Stanly and Aguilera, 1985). Several hypotheses have been postulated for this behaviour such as (a) Breakdown of phytic acid by phytase inhibits chelation of divalent cation rendering pectates in the middle lamella unsusceptible to softening (Muller, 1967; Moscose *et al*., 1984), (b) Pectin de-esterification by pectin methylesterase creates more free COOH sites for Ca and Mg binding the middle Lamella (Stanly and Aguilera, 1985), (c) Membrane degradation by phospholipids hydrolyzing enzymes leads to solute leakage and decreased turgor pressure (Priestley and Leopold, 1979; Jones and Boulter, 1983) (d) Cell wall material becomes lignified via polymerization of lignin precursors from amino acids pool and mediation of per-oxidase (Whitemore, 1978; Jackson and Marston, 1981; Haard, 1985) and (e) Oxidation of polyephenols under the action of polyphenol oxidase is followed by polymerization and complexing of reaction products with proteins (Elias, 1982). Reduced water uptake and a concomitant increase in cooking time as a result of storage (Zeb *et al*., 1991), supported the view that if the cause of hard bean phenomenon was reduction in the rate of cotyledon cell separation, then two possible reasons could be assigned (a) reduced middle lamella (pectin) solubility or (b) reduced imbibition (water uptake) value leading to a reduced turgor pressure which failed to force the cells apart, or both of these factors were involved to differing degrees (Jones and Boulter, 1983). The same authors postulated that reduced pectin solubility (observed in hard to cook seeds) was due to phytin breakdown, releasing Ca and Mg which formed cation bridges within the pectinaceous middle lamella, thus desolubilizing it. This was facilitated by pectin deestrification which created more free carboxyl sites. Reduction in the pH of stored grain flour as observed by Zeb *et al*. (1991) can also be explained partly on the basis of this increased free-COOH sites which contributed to acidity of the samples. Jackson and Marstan (1981) reported that the seed coat contribution to cooking time exceeded that of cotyledon in fresh beans but that contribution of the cotyledons to cooking time increased to maximum during storage. Evidence of Moscoso (1981) suggested that beans at high temperatures and humidity's underwent a reduction in phytic acid and an alteration in the ratio of monovalent to divalent cations. Role of enzymatic involvement in the hardening of seeds during storage has also been investigated, though the results were not conclusive (Aguilera and Ballivia, 1988).

CONCLUSIONS

It is concluded from the study that all the genotype varied significantly in all the parameters studied. Variety Ramzan and NM-92 were ranked 1st as for as cooking is concerned. These genotypes took minimum time for cooking and therefore, will be preferred by the consumers. NM-3 and C1/94-4-19 are the genotypes having maximum protein content. Genotype NM-98 was observed to be having minimum values of polyphenols and phytic acid. The later three genotypes, may, therefore, be a choice of a nutritionist. Genotype 99-CMG-058, with maximum water absorption properties can be better used for sprouting purposes.

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