Characteristics of F_2 Hybrids from Crosses between Korean Cultivars and Canadian Cultivars in Buckwheat(*Fagopyrum esculentum* Moench.)

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ABSTRACT

Korean cultivars of buckwheat(*Fagopyrum esculentum* Moench.) was crossed with Canadian cultivars in order to improve seed yield as well as leaf production of buckwheat for using as food and medicine. The agronomic characteristics and rutin contents of F_2 hybrids are investigated for further selection of superior lines.

Dry weight per plant was the highest in a line 1110(6.71g) and leaf weight per plant was the highest in a line 1110(1.91g). Hybrid seeds were 0.55 - 0.70cm long and 0.37 - 0.47cm wide on average. 100 seeds weight ranged from 2.57g to 3.58g. Line 1076 produced the longest seeds(0.70cm) and line 1186 was the longest in seed width. Line 1196 showed the highest 100 seeds weight(3.58g). The highest frequency of the LWR(length/width rate) was 0.66~0.70, indicating that seed shape of the hybrids was mostly oval.

Line 1087 showed the highest contents of rutin(77.26ppm). Lines 1090 and 1181 contained respectively rutin of 54.76ppm and 54.35ppm in the seeds. From the yield and rutin point of view, the most superior lines was line 1087 among the lines used for this study.

Key Words : buckwheat crosses, seed size and weight, rutin contents, Canadian cultivars, Korean cultivars

INTRODUCTION

Buckwheat has been used as a traditional food and medicine in Korea. Nowadays, buckwheat is being appreciated as a new crop for health food and medicine. It' s utilization and application for biotechnology and bio- industry is also increasing recently in the world.

Buckwheat contains rutin to be used as a medicinal agent for the treatment of vascular disorders. Rutin has been identified *in Fagopyrum esculentum, F. tartaricum* and *F. cymosum.* It occurs in concentrations of 3-6% of the dry weight, with F. tartaricum having the highest concentrations(Campbell, 1997). There now is a trend back to natural sources and a higher concentration of rutin would make the processing of buckwheat more economically feasible.

The varietal differences were significant for rutin content in the seed and the leaf(Park et al., 2000; Shim et al., 1998). The heritability of the rutin content in the seed and the leaf was estimated at 0.59 and 0.25, respectively(Campbell, 1997). The results indicated that the rutin content in the seed was one of the traits with a relatively high heritability among the main characters in

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Table 1. Breeding lines from crosses between Korean cultivars and Canadian varieties used for this experiment

Breeding	lines
a(1112)	: SW15$_T$KT$_P$(F2)
b(1076)	: SW1$_P$MnS$_T$
c(1077)	: KB$_T$SW15$_P$
d(1082)	: SW15$_T$MC$_P$
e(1087)	: SW15$_T$MnS$_P$
f(1088)	: SW15PKB$_T$
g(1089)	: Mamo2$_T$SW15$_P$
h(1090)	: MnS$_P$SW15$_T$
i(1110)	: SW1$_P$KT$_T$
j(1091)	: SW1$_T$Mamo2$_P$
k(1176)	: KB$_P$SW1$_T$
l(1180)	: SWM($_{PT}$)($_{PT}$)
m(1181)	: Mamo2$_T$SW2$_P$
n(1185)	: MC$_T$SW1$_P$
o(1196)	: KB$_T$SW2$_P$
p(1281)	: SW2$_P$KB$_T$

common buckwheat, and that the rutin content in the leaf was a trait comparatively affected by environmental conditions. Ohsawa and Tsutsumi(1993) reported that the varietal differences in rutin content in seeds were significant in 12 strains and varieties mainly from Japan. Shim et al.(1998) showed that the content of rutin tended to be higher in developed cultivars than landraces, and that in addition tocopherol content varied with buckwheat cultivars.

Buckwheat seeds contain many different nutrients such as protein, amino acids and minerals(Pomeranz, 1983). Buckwheat plants have been used as green vegetable at their early seedling stage(Choi et al., 1996). Kim et al.(2001) has developed buckwheat sprouts as a functional vegetable that could be used as a fresh vegetable, salad and for various other purposes including natural vegetable juice material.

In spite of this expanded use of buckwheat, the productivity of buckwheat is still limited to low level and it is attributed to the limitation of cultivar development by breeding barriers such as self-incompatibility and low level of grain yield by loss in cultivation and harvesting(Feszenko, 1986; Alekseeva and Malikov, 1992).

There are many good cultivars in Canada. They were mostly developed by Kado Research Ltd. in Morden, Canada. Kado has developed many superior cultivars and exported lots of Canadian buckwheat seeds to Japan market every year. Canadian cultivars are characterized by good quality and high yield. They are compared to Korean cultivars in several aspects such as seed size, seed shape and 1,000 seeds weight.

This study describes the agronomic characteristics and rutin content of F_2 hybrids obtained from the crosses between Korean cultivars and Canadian cultivars, which are being progressed aiming at the improvement of productivity in both seeds and leaves of buckwheat for using as food and medicine.

MATERIALS AND METHODS

Plant materials used for this study were Korean

Table 2. Phenotypic characteristics of breeding lines from intraspecific crosses between Korean buckwheat cultivars and Canadian buckwheat cultivars(F_2)

Breeding line	Plant length(m)	No. of branch (/plant)	Dry weight of stem per plant(g)	Leaf weight per plant(g)	Dry weight(g)
Suwon 1	0.89	3.5	1.8	0.59	2.39
Mancan	1.15	4.3	3.8	1.65	5.45
1112	0.85	3.1	2.0	0.09	2.09
1076	1.88	3.4	2.2	0.26	2.46
1077	0.82	2.2	1.5	0.25	1.75
1082	1.00	3.1	2.3	0.48	2.78
1087	1.03	3.0	2.0	0.75	2.75
1088	0.93	2.6	1.5	0.26	1.76
1089	0.89	3.4	1.7	0.41	2.11
1090	1.18	3.8	2.7	0.13	2.83
1091	0.85	1.3	1.0	0.14	1.14
1110	1.06	3.6	4.8	1.91	6.71
1176	1.17	4.1	4.2	0.12	4.32
1180	1.22	4.2	4.2	1.00	5.20
1181	1.02	3.8	3.1	0.88	3.98
1185	0.76	2.3	1.9	0.63	2.53
1196	1.15	4.0	3.8	0.29	4.09
1281	0.83	4.5	2.8	1.00	3.

cultivars(Suwon 1, Suwon 2, Suwon 15) developed by RDA, Korea and Canadian cultivars(Mamo, Koto, Mancan, Koban). Seeds were sown in vinyl pots and plants were transplanted to field in the combination of crosses. Wooden frames with cloth net were put on each field of cross combination to prevent open pollination. Sixteen lines were selected from the crosses in 2000 and produced F_2 generation in 2001(Table 1). Growth characteristics were investigated for F_1 hybrid plants in three replications and F_2 seeds were also investigated for seed characteristics such as seed size, length/width rate of seed, and 100 seeds weight. Growth characteristics investigated were plant height, number of branch, leaf dry weight, and dry weight of whole plant. Yield of whole plants on the basis of dry weight was estimated based on the averaged dry weight of 10 plants that were taken as samples.

Seeds of 5g were dried and milled for the preparation of rutin analysis. Rutin in the seeds of the F_2 hybrids was analyzed according to Kim et al.' s method reported previously(2001).

RESULTS AND DISCUSSION

As shown in Table 2, growth characteristics were investigated for F_2 plants. Line 1076 showed the longest plant height(1.88m) and line 1281 had the most branches(4.5). Dry weight per plant was the highest in a line 1110(6.71g) and leaf weight per plant was the highest in a line 1110(1.91g). This result means that line 1110 has a potential of high productivity of whole plants including leaf and stem. It is estimated to produce dried whole plants of 143kg per 10a. Hybrid plants obtained from crosses between Korean

Table 3. Seed characteristics of breeding lines from intraspecific crosses between Korean buckwheat cultivars and Canadian buckwheat cultivars(F_2)

Breeding line	Seed length(cm)	Seed width(cm)	100 seed wieght(g)
Suwon 1	0.60	0.44	2.98
Mancan	0.65	0.48	3.41
1112	0.63	0.45	3.33
1076	0.70	0.46	3.35
1077	0.63	0.44	2.93
1082	0.62	0.42	2.68
1087	0.55	0.41	3.01
1088	0.61	0.42	2.57
1089	0.61	0.42	2.62
1090	0.64	0.45	2.96
1091	0.59	0.37	2.47
1110	0.57	0.42	2.94
1176	0.64	0.44	3.38
1180	0.55	0.38	2.81
1181	0.63	0.46	3.32
1185	0.65	0.47	3.38
1196	0.66	0.44	3.58
1281	0.67	0.44	3.23

buckwheat landraces and Canadian buckwheat cultivars showed plant height ranging from 1.13m to 1,28m, number of branch ranging from 14 to 28, and dry weight ranging from 10g to 31g(unpublished data).

Seed characteristics were compared among F2 hybrid lines(Table 3). Hybrid seeds were 0.55 - 0.70cm long and 0.37 - 0.47cm wide on average. 100 seeds weight ranged from 2.57g to 3.58g. Line 1076 produced the longest seeds(0.70cm) and line 1186 was the longest in seed width. Line 1196 showed the highest 100 seeds weight(3.58g). Korean cultivars and Canadian cultivars used as control showed on average 100 seeds weight of 3.03 and 3.63g respectively. Lines 1087, 1112, 1176, 1181, 1185, 1196, and 1281 were almost same as Korean cultivars or were little higher than Korean cultivars and Candian cultivars in seed weight of buckwheat.

Hybrid seeds(F_4) obtained from the crosses between Korean buckwheat landraces(Cheongsongjaerae, Youngwoljaerae, Bongpyoungjaerae) and Canadian cultivars(Koto, Koban, Mancan) showed seed length ranging from 0.65cm to 0.78cm and seed width ranging from 0.46cm~0.57cm. Their 100 seeds weight ranged from 2.7g to 4.4g while 100 seed weight of Korean landraces and Canadian cultivars were 2.7g and 3.6g(unpublished data).

Figure 1 shows the length/width rates(LWR) of the hybrid seeds obtained from the crosses Korean cultivars and Canadian cultivars. The highest frequency of the LWR was 0.66~0.70, indicating that seed shape of the hybrids was mostly oval. This means that hybrid seeds became more round shape rather than Korean cultivars. This trend was consistency in the LWR(6:4) of hybrid seeds(F_5) obtained from the crosses Korean landraces and Canadian cultivars. From those results, buckwheat

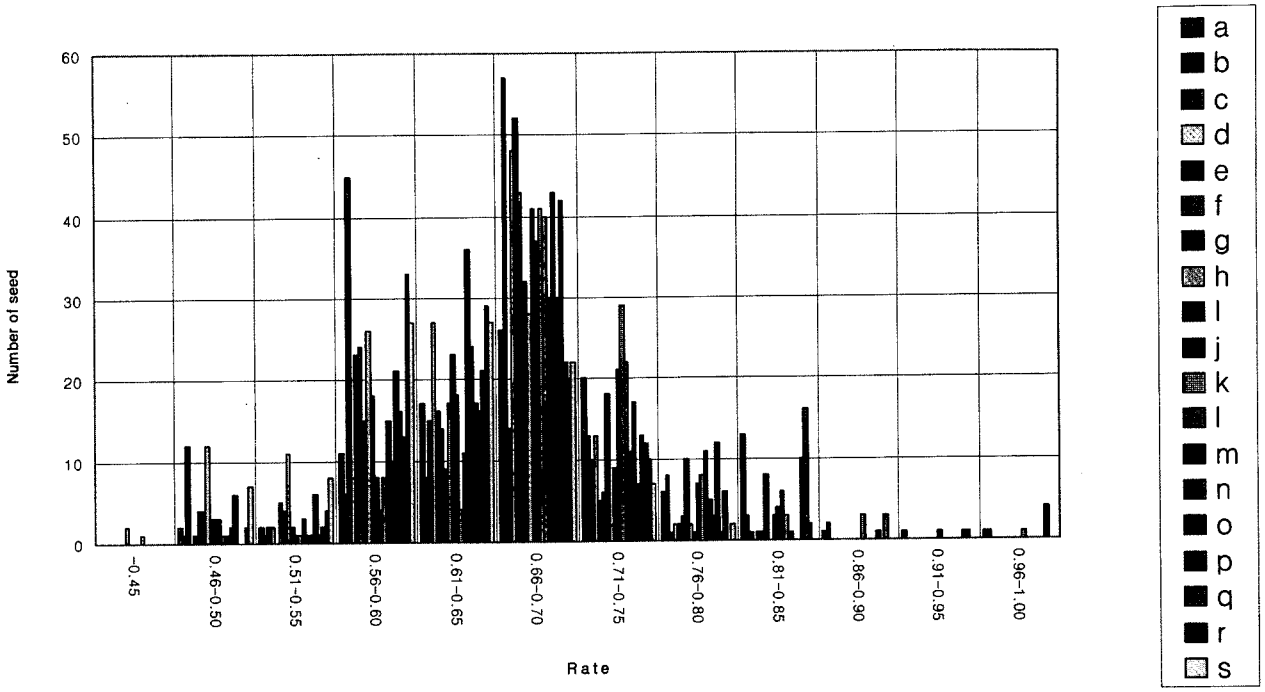

Fig. 1. Rate with/length of hybirds seeds from intraspecific crosses between Korean buckwheat cultivars and Canadian cultivars(a:1112, b:1076, c:1077, d:1082, e:1087, f:1088, g:1089, h:1090, i:1110, j:1091, k:1176, l:1180, m:1181, n:1185, o:1196, p:1281)

Table 3. Rutin content in breeding lines from intraspecific crosses between Korean buckwheat cultivars and Canadian buckwheat cultivars(F_2)

Breeding line	Rutin(ppm)
Suwon 1	28.85
Mancan	32.47
1076	21.93
1077	38.71
1082	20.80
1087	77.26
1088	27.48
1090	54.35
1091	12.99
1110	10.44
1112	23.21
1176	20.41
1180	15.82
1181	54.76
1185	29.61
1189	32.06
1196	24.55
1281	26.95

seeds are expected to be improved roundly by introducing related genes from Canadian cultivars to Korean cultivars.

Rutin contents in hybrid seeds varied to genotypes(Table 4). Line 1087 showed the highest contents of rutin(77.26ppm). Lines 1090 and 1181 contained respectively rutin of 54.76ppm and 54.35ppm in the seeds. Line 1110 was the lowest in rutin content among the lines used for this study. Other lines showed rutin contents ranging from 13ppm to 38ppm. Rutin contents in the seeds of lines 1087, 1090 and 1181 were similar to rutin contents in the leaf of lines 1110, 1180 and 1185. It was also higher than rutin in the seeds of Suwon No. 1 which is a Korean recommended cultivar. Shim et al.(1998) compared the rutin contents between Korean landraces and recommended cultivars. They reported that Korean landraces contained rutin of 9-15mg/100g while Korean cultivars had rutin of 18-30mg/100g.

From the yield and rutin point of view, the most superior line was line 1087 among the lines used for this experiment.

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