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Comparisons of phaseolin type and α-amylase inhibitor in common bean (*Phaseolus vulgaris* L.) in China

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ARTICLE INFO

Article history:
Received 5 February 2015
Received in revised form
29 September 2015
Accepted 27 November 2015
Available online 3 December 2015

Keywords:
Common bean
Phaseolin
α-Amylase inhibitor
Phenolic acid

ABSTRACT

The objective of this study was to characterize the phaseolin type and α-amylase (αAI) level in common bean (*Phaseolus vulgaris* L.) accessions deposited in the Chinese National Genebank. The 40 accessions sampled were common varieties originating in Asia, North America, South America, Europe, and Africa. No Inca (I-) phaseolin was observed in the accessions. Only four accessions contained Tendergreen (T-) phaseolin and the remaining 36 contained Sanilac (S-) phaseolin. αAI proteins extracted from nine accessions showed higher α-amylase inhibitory activity than the control (Phase 2, IC_{50} = 0.65 μg). These common bean accessions have potential use as nutraceutical ingredients.

1. Introduction

Common bean (*Phaseolus vulgaris* L.) is the most important food legume in the world, accounting for half of grain legumes in direct human consumption [1]. Common bean is rich in protein, unsaturated fatty acids, and dietary fiber in addition to vitamins and minerals [2]. Recently, researchers have focused interest on common bean proteins with specific functions, such as in anti-obesity [3], anti-hypersensitivity, and antioxidant [4] and anti-diabetic [5] activities. Phaseolin is the major storage protein in common bean seed, accounting for about 50% of total protein. Phase 2 (Pharmachem Laboratories, Kearny, NJ, USA) is a common bean extract product that can reduce human body weight at a daily dose of 500–3000 mg (D. Brady, N. D. CarbXzyme). Clinical studies also showed that Phase 2 has the potential to induce weight loss and reduce spikes in blood sugar caused by carbohydrates through its α-amylase inhibiting activity [6–8].

A proteinaceous inhibitor of α-amylase (αAI) isolated from common bean has been reported to have great potential to treat obesity and diabetes without side effects such as asthma and dermatitis [9]. Several companies have marketed common bean αAI extracts for controlling appetite and energy intake [10]. To date, information on phaseolin type and αAI

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Peer review under responsibility of Crop Science Society of China and Institute of Crop Science, CAAS.
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http://dx.doi.org/10.1016/j.cj.2015.09.002

deposited in the Chinese National Genebank, Beijing, China is very limited. To contribute to the knowledge in this area, we investigated the phaseolin types and αAI levels of 40 common bean accessions deposited in the Genebank.

2. Materials and methods

2.1. Materials

Forty numbered common bean accessions (Table 1) were obtained from the Chinese National Genebank. The sampled accessions were the most common varieties originating in Asia, North America, South America, Europe, and Africa. Each sample was milled into fine (60-mesh) powder, cooled immediately, and stored at –20 °C. Porcine pancreatic α-amylase, ammonium sulfate, *tert*-butanol and bovine serum albumin were purchased from Sigma Chemical Co. (St. Louis, MO, USA). Other chemicals used were of analytical grade. Phase 2 extracted from white kidney bean was used as a reference for comparison.

2.2. Isolation and purification of phaseolin

Phaseolin was purified as described by Carrasco-Castilla et al. [11]. The powder sample was defatted with hexane for 24 h and extracted in NaOH solution (1:10, w/v, pH 9.5), with agitation at 40 °C for 30 min. The supernatant from centrifugation at 5000 ×*g* for 30 min was adjusted to pH 4.5 with 1 mol L^{-1} HCl.

Table 1 – Information, α-amylase inhibitory activities, specific porcine pancreatic α-amylase inhibitory activities, and amounts of αAI necessary for 50% inhibition of α-amylase activity (IC_{50}) in common bean accessions.

No.	Accession code	Origin	Seed color	Total activity (U g^{-1})	Specific activity (U mg^{-1} protein)	IC_{50}
1	F0005800	Colombia	Red	4068.9 ± 245.9	1356.3 ± 117.1	0.62 ± 0.11 l
2	F0005801	Colombia	Red	3300.4 ± 368.5*	1100.1 ± 102.8*	0.77 ± 0.08
3	F0005860	China	Light brown	3603.5 ± 276.9*	1201.1 ± 115.1	0.70 ± 0.07
4	F0005861	China	Black	2501.9 ± 335.2*	834.0 ± 81.7*	1.01 ± 0.12#
5	F0005862	China	White	3970.7 ± 316.0	1323.5 ± 111.6	0.64 ± 0.06
6	F0005863	United States	White	2386.7 ± 206.7*	795.5 ± 96.8*	1.06 ± 0.18#
7	F0005865	Colombia	Red	3150.9 ± 193.7*	1050.3 ± 108.9*	0.81 ± 0.03
8	F0005870	Mexico	Black	2297.0 ± 214.6*	765.6 ± 95.2*	1.10 ± 0.07#
9	F0005873	Peru	White	2049.4 ± 265.2*	683.1 ± 70.2*	1.24 ± 0.02#
10	F0005874	Mexico	Dark brown	3402.8 ± 298.3*	1134.2 ± 116.2*	0.75 ± 0.10
11	F0005875	Brazil	Black	1485.8 ± 305.4*	495.2 ± 31.5*	1.71 ± 0.05
12	F0005876	Mexico	Black	2852.0 ± 328.2*	950.7 ± 91.1*	0.89 ± 0.06
13	F0005877	Venezuela	Black	4559.9 ± 318.3	1519.9 ± 167.8	0.56 ± 0.08
14	F0005879	Colombia	Red	3706.0 ± 286.2*	1235.3 ± 145.8	0.68 ± 0.14
15	F0005881	Mexico	Light brown	3372.9 ± 261.2*	1124.3 ± 189.4*	0.75 ± 0.05
16	F0005882	Portugal	Red	3488.2 ± 285.4*	1162.7 ± 152.2*	0.73 ± 0.08
17	F0005885	Argentina	White	3441.2 ± 249.1*	1147.1 ± 121.8*	0.74 ± 0.12
18	F0005886	Brazil	Dark brown	3727.3 ± 337.5*	1242.4 ± 121.2	0.68 ± 0.08
19	F0005888	Bulgaria	White	3360.1 ± 354.2*	1120.0 ± 168.8*	0.75 ± 0.09
20	F0005889	Bulgaria	Light brown	4308.0 ± 301.5	1436.0 ± 125.6	0.59 ± 0.05
21	F0005891	Haiti	Red	3624.8 ± 192.1*	1208.2 ± 163.7	0.70 ± 0.03
22	F0005892	Peru	White	1912.7 ± 315.4*	637.6 ± 50.0*	1.33 ± 0.26#
23	F0005893	Mexico	Light brown	4286.6 ± 383.5	1428.8 ± 115.5	0.84 ± 0.14
24	F0005896	Mexico	Light brown	2980.1 ± 346.3*	993.3 ± 95.1*	0.85 ± 0.06#
25	F0005897	Mexico	Light brown	4150.0 ± 312.3	1383.3 ± 185.5	0.61 ± 0.07
26	F0005898	Tanzania	Red	3970.7 ± 243.4	1323.5 ± 107.4	0.64 ± 0.09
27	F0005899	Turkey	Brown	3513.8 ± 296.7	1171.2 ± 191.2*	0.72 ± 0.07
28	F0005900	Guatemala	Red	3906.6 ± 256.1	1302.2 ± 155.7	0.65 ± 0.07
29	F0005904	Brazil	Light brown	3219.2 ± 243.6*	1073.0 ± 110.1*	0.79 ± 0.01
30	F0005905	Bolivia	Brown	3227.8 ± 288.2*	1075.9 ± 120.6*	0.79 ± 0.06
31	F0005906	Dominican Republic	Red	3014.3 ± 277.5*	1004.7 ± 106.6*	0.84 ± 0.09
32	F0005907	Ecuador	Black	2694.1 ± 246.3*	898.0 ± 82.4*	0.94 ± 0.07#
33	F0005909	Colombia	Black	3125.3 ± 283.3*	1041.7 ± 117.0*	0.81 ± 0.05
34	F0005910	Colombia	Black	3552.3 ± 283.5	1184.1 ± 101.1*	0.71 ± 0.04
35	F0005911	Haiti	Black	1511.4 ± 330.8*	503.8 ± 53.5*	1.68 ± 0.06#
36	F0005912	Honduras	Red	3488.2 ± 341.1	1162.7 ± 112.3*	0.73 ± 0.05
37	F0005914	Macedonia	White	1840.2 ± 363.6*	613.4 ± 56.1*	1.38 ± 0.09#
38	F0005915	United States	White	5776.7 ± 352.1#	1925.5 ± 104.3#	0.44 ± 0.08*
39	F0005917	United States	Brown	5170.4 ± 297.7#	1723.4 ± 115.8#	0.49 ± 0.05
40	F0005918	United States	Brown	4559.9 ± 286.0	1519.9 ± 116.7	0.56 ± 0.07
41	Phase 2			4367.7 ± 261.3	1455.9 ± 108.2	0.65 ± 0.04

Data are expressed as mean ± standard deviation of triplicate samples.
These accessions showed significantly ($P < 0.01$) higher levels than Phase 2.
* These accessions showed significantly ($P < 0.01$) lower levels than Phase 2.