CHAPTER V
RESULTS

5.1 Characteristic of legumes

All legumes including mung bean, black bean, red kidney bean, white bean, soybean and peanut were analyzed as raw whole legumes, cooked whole legumes and raw seed coat. Color of legumes in this study was determined to control sample variation from different batches, thus increasing sample reliability (Table 5.1). The moisture content of legumes was in the range of 1.9–8.8% (Table 5.2).

Table 5.1 The color of six legumes including mung bean, black bean, red kidney bean, white kidney bean, soybean and peanut using C.I.E. LAB system.

Type of legumes	***Color value***		
	*L**	*a**	*b**
Mung bean	37.20 ± 0.05	–0.16 ± 0.06	25.48 ± 0.10
Black bean	19.39 ± 0.30	0.92 ± 0.11	1.4 ± 0.18
Red kidney bean	23.34 ± 0.21	18.02 ± 0.13	8.53 ± 0.14
White kidney bean	84.34 ± 0.06	1.48 ± 0.02	16.38 ± 0.02
Soybean	58.29 ± 0.28	12.84 ± 0.11	23.87 ± 0.01
Peanut	56.16 ± 0.11	12.78 ± 0.02	23.87 ± 0.01

Results are mean ± SD of triplicate analyzed.

Table 5.2 The moisture content of different legumes in different forms including raw whole legumes, cooked whole legumes and raw seed coats using using *Association of Analytical Communities (*AOAC, 2005) method.

Type of legumes	***Moisture content (%)***		
	Raw whole legumes	***Cooked whole legumes***	***Raw seed coat***
Mung bean	8.64 ± 0.07	1.95 ± 0.07	4.75 ± 0.10
Black bean	7.08 ± 0.10	4.11 ± 0.02	6.20 ± 0.01
Red kidney bean	7.56 ± 0.02	3.15 ± 0.06	6.46 ± 0.02
White kidney bean	8.82 ± 0.05	2.75 ± 0.02	4.38 ± 0.04
Soybean	6.30 ± 0.02	4.79 ± 0.02	5.24 ± 0.04
Peanut	2.85 ± 0.12	4.70 ± 0.09	7.65 ± 0.24

5.2 Bioactive compounds

Phenolic acid and flavonoid contents of each legume are different (Table 5.3, APPENDIX K). Bioactive compounds in mung bean, black bean and red kidney bean were classified as flavonoid moieties. Mung bean contained apigenin (22.19 ± 0.53 µg/g), while red kidney bean comprised of quercetin (661.48 ± 9.06 µg/g) and kaemferol (58.23 ± 0.33 µg/g), respectively. Black bean contained only quercetin (272.68 ± 6.60 µg/g). Total flavonoid content in red kidney bean (719.71 ± 9.39 µg/g) was higher than that of black bean (272.68 ± 6.60 µg/g). Peanut showed only phenolics, *p*–coumaric acid (49.84 ± 1.77 µg/g). Bioactive compounds were not found in white kidney bean and soybean in this study.

Table 5.3 Phenolic acids and flavonoids in six legumes (based on dry weight)

Legumes	Phenolic acid	Total	Flavonoids (µg/g)			Total flavonoids
	p–coumaric	Phenolic acids	Quercetin	Kaemferol	Apigenin	
Mung bean	ND	ND	ND	ND	22.19 ± 0.53^{a}	22.19 ± 0.53^{c}
Black bean	ND	ND	272.68 ± 6.60^{b}	ND	ND	272.68 ± 6.60^{b}
Red kidney bean	ND	ND	661.48 ± 9.06^{a}	58.23 ± 0.33^{a}	ND	719.71 ± 9.39^{a}
White kidney bean	ND	ND	ND	ND	ND	ND
Soybean	ND	ND	ND	ND	ND	ND
Peanut	49.84 ± 1.77^{a}	49.84 ± 1.77^{a}	ND	ND	ND	ND

All data were expressed by mean values of three independent samples (n=3) ± standard deviation.
Value with different letters (a–c) within column were significantly different with $p < 0.05$
ND = Not detect

5.3 Antioxidant capacities

This study was focused on total phenolic contents (TPCs) and antioxidant activities of raw and cooked legumes as well as their seed coats (Table 5.4). Antioxidant activities were measured using DPPH radical scavenging, FRAP and ORAC assays, while the TPCs were analyzed using Folin–Ciocalteu reagent. As results, antioxidant activities of raw (uncooked) legumes were in a range of 1.8–8.2 μmol TE/g dry weight as being measured by DPPH radical scavenging assay, 1.2–19.6 μmol TE/g dry weight being measured by FRAP assay and 34–266 (μmol TE/g dry weight) being measured by ORAC assay. Black bean presented the highest antioxidant activity, while white kidney bean possessed the lowest. Similar results were observed with TPCs (the range of 0.45–3.1 mg GAE/g dry weight), in which black bean was found to exhibit the highest TPCs (3.05 ± 0.07 mg GAE/g dry weight), followed by peanut, red kidney bean, mung bean, soybean and white kidney bean, respectively.

As for cooked legumes, the antioxidant activities were in the range of 4.0–14.7 μmol TE/g dry weight, 0.7–21.7 μmol TE/g dry weight, and 65.5–264.5 μmol TE/g dry weight as being measured by DPPH radical scavenging, FRAP and ORAC assays, respectively. TPCs of cooked legumes were in the range of 0.8–3.1 mg GAE/g dry weight. Cooked black bean presented the highest antioxidant activities and TPCs, while cooked white kidney bean possessed the lowest. Interestingly, heat treatment was found to be a significant factor that increased antioxidant capacities and TPCs of legumes. It was found that the antioxidant activities and TPCs of cooked legumes were higher than those of raw legumes.

Antioxidant activities of seed coats were in the range of 14–15 μmol/g dry weight, 260–418 μmol TE/g dry weight and 1160–1424 μmol/g dry weight as being measured by DPPH radical scavenging, FRAP and ORAC assays, respectively. Their TPCs were in the range of 25–28 mg GAE/g dry weight. Black bean and red kidney bean exhibited the highest antioxidant activities and TPCs, while soybean possessed the lowest. Almost all legume seed coats provided higher TPC and antioxidant activity than those of raw whole legumes, in exception of white kidney bean and soybean. Interestingly, TPCs of all samples were strongly correlated to antioxidant activities (Table 5.5).

Table 5.4 Antioxidant activities and total phenolic contents from different types of legumes including mung bean, black bean, red kidney bean, white kidney bean, soybean and peanut in both raw and cooked forms. Antioxidant activities and total phenolic contents of seed coat were also investigated in parallel with whole legumes.

Type of bean	*Antioxidant activities (µmol TE/g dry weight)*			*Folin–Ciocalteu assay (mg GAE/g dry weight)*
	DPPH assay	*FRAP assay*	*ORAC assay*	
Raw legume				
Mung bean	4.93 ± 0.22 ^{c,*,EF}	5.48 ± 0.22 ^{c,*,FG}	265.96 ± 0.07 ^{a,*,E}	1.92 ± 0.01 ^{d,*,FG}
Black bean	8.17 ± 0.36 ^{a,*,C}	19.57 ± 1.21 ^{a,*E}	235.37 ± 0.59 ^{b,*,F}	3.05 ± 0.07 ^{a,*,EF}
Red kidney bean	7.19 ± 0.13 ^{b,*,D}	8.40 ± 0.04 ^{b,*,FG}	180.82 ± 4.80 ^{c,*,H}	2.15 ± 0.09 ^{c,*,FG}
White kidney bean	2.60 ± 0.10 ^{d,*,HI}	1.18 ± 0.02 ^{e,*,G}	33.94 ± 1.74 ^{f,*,N}	0.45 ± 0.02 ^{f,*,H}
Soybean	1.81 ± 0.07 ^{e,*,I}	2.97 ± 0.30 ^{d,*,FG}	92.61 ± 5.42 ^{e,*,JK}	1.62 ± 0.03 ^{e,*,FG}
Peanut	7.01 ± 0.02 ^{b,*,D}	6.10 ± 0.21 ^{c,*,FG}	124.08 ± 7.63 ^{d,*,I}	2.53 ± 0.03 ^{b,*,EF}
Cooked legume				
Mung bean	8.80 ± 0.35 ^{c,**,C}	7.96 ± 0.46 ^{c,**,FG}	264.51 ± 3.31 ^{a,*,E}	2.37 ± 0.02 ^{b,**,FG}
Black bean	14.69 ± 0.20 ^{a,**,A}	21.68 ± 0.67 ^{a,*E}	220.92 ± 1.34 ^{b,**,G}	2.94 ± 0.03 ^{a,*,EF}
Red kidney bean	10.95 ± 0.37 $^{b,**.B}$	10.42 ± 0.02 ^{b,**,F}	174.27 ± 0.97 ^{d,*,H}	2.20 ± 0.10 ^{c**,FG}
White kidney bean	4.17 ± 0.04 ^{f,**,FG}	0.71 ± 0.00 ^{f,**,G}	65.48 ± 1.69 ^{f,**,L}	0.83 ± 0.07 ^{e,**,FG}
Soybean	5.38 ± 0.01 ^{e,**,E}	4.54 ± 0.12 ^{e,**,FG}	103.16 ± 0.54 ^{e,**,J}	1.74 ± 0.02 ^{d,**,FG}
Peanut	7.26 ± 0.36 ^{d,*,D}	6.78 ± 0.12 ^{d,**,FG}	181.63 ± 4.16 ^{c,**,H}	3.06 ± 0.12 ^{a,*,EF}
Seed coat				
Mung bean	14.74 ± 0.28 ^{a,A}	101.63 ± 4.48 ^{d,D}	1089.37 ± 16.31 ^{c,C}	13.93 ± 1.63 ^{c,C}
Black bean	15.06 ± 0.39 ^{a,A}	418.01 ± 6.09 ^{a,A}	1424.73 ± 7.25 ^{a,A}	25.94 ± 0.16 ^{ab,B}
Red kidney bean	14.81 ± 0.57 ^{a,A}	269.32 ± 3.63 ^{b,B}	1160.12 ± 5.66 ^{b,B}	28.32 ± 1.24 ^{a,A}
White kidney bean	3.26 ± 0.05 ^{b,GH}	0.90 ± 0.19 ^{e,G}	83.25 ± 0.17 ^{e,K}	4.17 ± 0.68 ^{d,DE}
Soybean	3.23 ± 1.11 ^{b,GH}	1.31 ± 0.08 ^{e,G}	47.63 ± 1.69 ^{f,M}	4.83 ± 0.02 ^{d,D}
Peanut	15.26 ± 0.24 ^{a,A}	240.79 ± 7.59 ^{c,C}	968.88 ± 9.80 ^{d,D}	25.07 ± 0.12 ^{b,B}

All data were expressed by mean values ± standard deviation

a,b,c…… Significant difference (p<0.05) within the same sample group and detection method using one–way ANOVA followed by Tukey's–b *post hoc* test

A,B,C….. Significant difference (p<0.05) within the same method group using one–way ANOVA followed by Tukey's–b *post hoc* test

*,**……. Significant difference between raw and cooked beans using t–test ($P<0.05$)

Cooking condition was boiling at 96–98 C^0 for 20 minutes

Table 5.5 Pearson correlation between antioxidant activities and total phenolic contents of different legumes regarding the effect of cooking process and legume parts.

Type of legumes	*Pearson correlation of TPCs and antioxidant activities*		
	DPPH	***FRAP***	***ORAC***
Raw bean	0.835	0.815	0.698
Cooked bean	0.683	0.695	0.782
Seed coat	0.889	0.915	0.888

Correlation is significant at the 0.01 level

5.4 Lipase inhibitory activities

It was found that legumes were not only the rich sources of antioxidants, but also anti–lipase agents (Table 5.6). Raw legumes exhibited anti–lipase activities within the range of 28–52% inhibition. Raw red kidney bean was found to exhibit the highest lipase inhibitory activity, followed by black bean, mung bean, peanut, white kidney bean and soybean, respectively. Interestingly, heat treatment was found to be the significant factor that increased lipase inhibitory activity (39–64% inhibition). In cooked legumes, black bean showed the highest lipase inhibitory activity, followed by those of red kidney bean, mung bean, soybean, peanut, and white kidney bean, respectively.

Table 5.6 Lipase inhibitory activities (percentage of inhibition) of raw and cooked legumes including mung bean, black bean, red kidney bean, white bean, soy bean and peanut.

Type of legumes	% Inhibition of lipase	
	Raw	Cooked
Mung bean	42.02 ± 3.47 ^{bc,*}	57.67 ± 1.29 ^{b,**}
Black bean	44.93 ± 1.89 ^{b,*}	64.25 ± 1.92 ^{a,**}
Red kidney bean	51.87 ± 2.53 ^{a,*}	59.86 ± 0.26 ^{b,**}
White kidney bean	31.27 ± 1.60 ^{d,*}	38.71 ± 2.37 ^{d,**}
Soybean	28.10 ± 0.62 ^{d,*}	51.05 ± 2.31 ^{c,**}
Peanut	38.71 ± 1.51^{c,*}	40.41 ± 0.86 ^{d,*}

Concentration of exaction = 10 mg/mL
All data were expressed by mean values ± standard deviation.
$^{a–d}$ showed significant difference ($p < 0.05$) within the same column using one–way ANOVA followed by Tukey's$^{s–b}$ *post hoc* test
*,** showed significant difference between raw bean and cooked bean ($p < 0.05$)

In seed coat, red kidney bean was found to possess the highest lipase inhibitory activity (89.91 ± 1.72 % inhibition), followed by those of soybean, white kidney bean, and black bean, respectively (Table 5.7). As in the case of white kidney bean and soy bean (10 mg/mL), seed coat showed higher lipase inhibitory activity than its raw legume.

Table 5.7 Lipase inhibitory activities (percentage of inhibition) of seed coat of mung bean, black bean, red kidney bean, white bean, soy bean and peanut.

Type of seed coats	% Inhibition of lipase	Concentration(mg/mL)
Mung bean	ND	0.5
Black bean	37.15 ± 1.50	0.5
Red kidney bean	89.91 ± 1.72	0.5
White kidney bean	68.74 ± 1.68	10
Soybean	73.54 ± 1.39	10
Peanut	ND	0.5

All data were expressed by mean values ± standard deviation.
ND = not detect

5.5 α–Amylase and α–glucosidase inhibitory activities

This part of the experiments was focused on α–amylase and α–glucosidase, the digestive enzymes that hydrolyze carbohydrate into glucose subunits.

The results suggested that all legumes used in the experiments were capable of inhibiting α–amylase reaction (Table 5.8). Raw legumes exhibited anti–α–amylase activities within the range of 23–57% inhibition. Raw mung bean exhibited the highest α–amylase inhibitory activity, while soybean exhibited the lowest. Interestingly, heat treatment was found to lower α–amylase inhibitory activities of these legumes (3–32% inhibition). The decrease in α–amylase inhibitory activity was found to be the greatest in mung bean, while the lowest was found in red kidney bean and peanut. Nevertheless, cooked red kidney bean and peanut were found to exhibit the highest α–amylase inhibitory activities among cooked legumes, while cooked soybean and mung bean exhibited the lowest.

Seed coat showed higher anti–amylase activity than raw legumes. Legumes with darker seed coat (mung bean, black bean, red kidney bean and peanut) were found to exhibit higher α–amylase inhibitory activities than those with lighter seed coat (white kidney bean and soybean) (Table 5.9). Red kidney bean was found to possess the highest α–amylase inhibitory activity (64% inhibition at the extraction concentration of 0.63 mg/mL), while white kidney bean possessed the lowest (40% inhibition at the extraction concentration of 12.5 mg/mL).

Table 5.8 Percentage of inhibition of α–glucosidase and α–amylase inhibitory activities of raw and cooked legumes including mung bean, black bean, red kidney bean, white bean, soy bean and peanut.

Type of legumes	***% Inhibition***			
	α–Amylase		***α–Glucosidase***	
	Raw	***Cooked***	***Raw***	***Cooked***
Mung bean	$57.12 \pm 1.23^{a,*}$	$4.16 \pm 0.66^{d,**}$	$37.83 \pm 1.40^{e,*}$	$28.27 \pm 0.18^{c,**}$
Black bean	$44.84 \pm 0.75^{b,*}$	$19.16 \pm 5.26^{b,**}$	$43.30 \pm 1.34^{d,*}$	$16.84 \pm 0.10^{e,**}$
Red kidney bean	$33.81 \pm 2.33^{c,*}$	$32.15 \pm 2.52^{a,*}$	$49.82 \pm 1.85^{c,*}$	$37.28 \pm 0.38^{a,**}$
White kidney bean	$30.19 \pm 2.16^{c,*}$	$11.70 \pm 0.80^{c,**}$	$43.50 \pm 2.59^{d,*}$	$30.96 \pm 1.36^{b,**}$
Soybean	$23.10 \pm 1.19^{d,*}$	$2.92 \pm 1.80^{d,**}$	$55.13 \pm 1.29^{b,*}$	$22.86 \pm 1.00^{d,**}$
Peanut	$33.63 \pm 1.32^{c,*}$	$26.15 \pm 4.89^{a,*}$	$60.62 \pm 2.34^{a,*}$	$27.26 \pm 1.47^{c,**}$

All data were expressed by mean values ± standard deviation.
$^{a–d}$ showed significant difference ($p < 0.05$) within the same column using one–way ANOVA followed by Tukey's–b *post hoc* test
*,** showed significant difference between raw bean and cooked bean ($p < 0.05$)
Concentration of extract = 12.5 mg/mL.

Table 5.9 Inhibitory activities of α–amylase and α–glucosidase of seed coats from different types of legumes including mung bean, black bean, red kidney bean, white bean, soy bean and peanut.

Type of seed coats	*α–Amylase*		*α–Glucosidase*	
	% Inhibition	*Concentration (mg/mL)*	*% Inhibition*	*Concentration (mg/mL)*
Mung bean	31.73 ± 1.85	0.63	72.15 ± 1.68	0.06
Black bean	36.81 ± 1.65	0.63	83.48 ± 0.58	0.06
Red kidney bean	63.70 ± 1.04	0.63	92.75 ± 0.48	0.06
White kidney bean	39.66 ± 1.20	12.5	41.60 ± 0.45	12.5
Soybean	45.01 ± 2.52	12.5	35.78 ± 1.39	12.5
Peanut	18.71 ± 0.30	0.63	64.40 ± 0.58	0.06

All data were expressed by mean values ± standard deviation.

Likewise, raw legumes exhibited the α–glucosidase inhibitory activity within the range of 38–61% inhibition (Table 5.8). Raw peanut exhibited the highest α–glucosidase inhibitory activity, followed by those of soybean, red kidney bean, white bean, black bean and mung bean, respectively. Similar to the reactions of α–amylase, heat treatment was found to lower α–glucosidase inhibitory activities of these legumes (17–37% inhibition). The decrease in α–glucosidase inhibitory activity was found to be in the similar range (1.34–2.57–fold lower than raw legumes) within each type of legumes. Nevertheless, cooked peanut was found to exhibit the highest α–amylase inhibitory activities, while cooked white kidney bean and black bean exhibited the lowest.

Similar to anti–α–amylase reaction, legumes with darker seed coat (mung bean, black bean, red kidney bean and peanut) were found to exhibit higher α–glucosidase inhibitory activities than those of legumes with lighter seed coat (white kidney bean and soybean) (Table 5.9). Seed coat of red kidney bean provided the highest anti–α–glucosidase activity (93% inhibition with extraction concentration of 0.06 mg/mL), while the lowest α–glucosidase inhibitory activity was found in soybean (36% inhibition with extraction concentration of 12.5 mg/mL). Almost all seed coats exhibited higher anti–glucosidase activity than raw whole legumes, except for white kidney bean and soy bean.

5.6 Angiotensin–converting enzyme inhibitory activity

As results, the only detectable anti–ACE activity was found in cooked mung bean (80% inhibition), while the rest was undetectable (Table 5.10). It was possible that the extraction concentration used in this experiment was low such that the ACE inhibitory activity might be measurable if applying higher concentration of the extract.

Table 5.10 Angiotensin–converting enzyme inhibitory activities of raw and cooked legumes including mung bean, black bean, red kidney bean, white bean, soy bean and peanut.

Type of legumes	***% Inhibition of ACE***	
	Raw	***Cooked***
Mung bean	ND	80.23 ± 5.67
Black bean	ND	ND
Red kidney bean	ND	ND
White kidney bean	ND	ND
Soybean	ND	ND
Peanut	ND	ND

All data were expressed by mean values ± standard deviation.
Concentration of extract = 10 mg/mL.

Interestingly, seed coats of some legumes with darker color could inhibit ACE activities (Table 5.11). Seed coats of black bean, mung bean and red kidney bean exhibited ACE inhibitory activities with 51, 42 and 14% inhibition, respectively, at the extraction concentration of 5 mg/mL. Under the same condition, anti–ACE reaction of seed coats from legumes with lighter color was undetectable.

Table 5.11 Angiotensin–converting enzyme inhibitory activities of seed coats from different types of legumes including mung bean, black bean, red kidney bean, white kidney bean, soybean and peanut.

Type of seed coats	*% Inhibition of ACE*	*Concentration (mg/mL)*
Mung bean	41.73 ± 0.64 [b]	5
Black bean	51.24 ± 3.34 [a]	5
Red kidney bean	13.84 ± 0.71 [c]	5
White kidney bean	ND	5
Soybean	ND	5
Peanut	ND	5

All data were expressed by mean values ± standard deviation.
[a–c] showed significant difference ($p < 0.05$) within the same column using one–way ANOVA followed by Tukey's–b *post hoc* test

5.7 Cholinesterase inhibitory activity

Cholinesterase enzymes in cholinergic hypothesis of AD occurrence are AChE and BChE. As results, it was found that only raw soybean could inhibit AChE activity (4% inhibition with the extraction concentration of 10 mg/mL), while the rest was undetectable (Table 5.12). Heat treatment was found to lower this activity, in which AChE inhibitory activity of soybean was vanished after cooking. Anti–BChE activities, on the other hand, were observed in all raw legumes (3–19% inhibition) in exception of red kidney bean. Soybean was found to exhibit the highest BChE inhibitory activity, while red kidney bean exhibited the lowest. Similar to AChE reaction, heat treatment could destroy anti–BChE agents such that BChE inhibitory activity of all cooked legumes were undetectable.

Interestingly, anti–AChE (3–50% inhibition) and anti–BChE (2–68% inhibition) activities were detected in seed coats of all legumes (Table 5.13). Seed coat of red kidney bean was found to exhibit the highest AChE and BChE inhibitory activities, while that of white kidney bean exhibited the lowest.

Table 5.12 Cholinesterase (acetylcholinesterase and butyrylcholinesterase) inhibitory activities of raw and cooked legumes including mung bean, black bean, red kidney bean, white bean, soy bean and peanut.

Type of legumes	*% Inhibition*			
	AChE		*BChE*	
	Raw	*Cooked*	*Raw*	*Cooked*
Mung bean	ND	ND	7.38 ±0.80 [b]	ND
Black bean	ND	ND	6.68± 0.97 [b]	ND
Red kidney bean	ND	ND	ND	ND
White kidney bean	ND	ND	3.22 ± 0.50 [c]	ND
Soybean	3.89 ± 0.04	ND	19.07 ± 1.01 [a]	ND
Peanut	ND	ND	8.26 ± 2.17 [b]	ND

All data were expressed by mean values ± standard deviation.
[a–c] showed significant difference ($p < 0.05$) within the same column using one–way ANOVA followed by Tukey's–b *post hoc* test.
Concentration of extract = 10 mg/mL.
ND = Not detect

Table 5.13 Cholinesterase (acetylcholinesterase and butyrylcholinesterase) inhibitory activities of seed coats from different types of legumes including mung bean, black bean, red kidney bean, white kidney bean, soybean and peanut.

Type of seed coats	*% Inhibition*		*Concentration (mg/mL)*
	AChE	*BChE*	
Mung bean	16.40 ± 0.27	22.02 ± 0.81	0.05
Black bean	33.16 ± 0.96	39.76 ± 1.93	0.05
Red kidney bean	49.63 ± 1.91	67.78 ± 0.09	0.05
White kidney bean	3.44 ± 0.40	2.36 ± 0.88	10
Soybean	11.66 ± 1.01	27.87 ± 2.14	10
Peanut	30.93 ± 2.17	18.93 ± 0.67	0.05

All data were expressed by mean values ± standard deviation.

5.8 β–secretase Inhibitory Activity

The results indicated that all raw legumes could inhibit β–secretase activity within the range of 9–70% inhibition (Table 5.14). Raw soybean provided the highest anti–β–secretase, while black bean exhibited the lowest inhibition. Heat treatment seemed to elevate the β–secretase inhibitory activity (57–96% inhibition). Cooked soybean possessed the highest inhibition, while red kidney bean exhibited the lowest.

Interestingly, only β–secretase inhibitory activities of seed coats from mung bean and black bean were observed (Table 5.15). Mung bean exhibited higher anti–β–secretase activity than that of black bean (73 and 54% inhibition, respectively) under the extraction concentration of 5 mg/mL. The rest showed undetectable activity.

Table 5.14 β–secretase inhibitory activities of raw and cooked legumes including mung bean, black bean, red kidney bean, white bean, soy bean and peanut.

Type of legumes	***% Inhibition BACE1***	
	Raw	***Cooked***
Mung bean	60.91 ± 4.43 ^{b,*}	64.70 ± 4.43 ^{d,*}
Black bean	8.89 ± 0.48 ^{f,*}	62.90 ± 1.44 ^{d,**}
Red kidney bean	30.35 ± 0.62 ^{e,*}	56.59 ± 0.52 ^{e,**}
White kidney bean	34.59 ± 0.21 ^{d,*}	76.81 ± 1.06 ^{c,**}
Soybean	70.34 ± 1.01 ^{a,*}	95.86 ± 0.14 ^{a,**}
Peanut	37.25 ± 2.06 ^{c,*}	82.80 ± 0.14 ^{b,**}

All data were expressed by mean values ± standard deviation.
$^{a–f}$ showed significant difference ($p < 0.05$) within the same column using one–way ANOVA followed by Tukey's–b *post hoc* test
*,** showed significant difference ($p < 0.05$) between raw bean and cooked bean
Concentration of extract = 10 mg/mL.

Table 5.15 β–Secretase inhibitory activities of seed coats from different types of legumes including mung bean, black bean, red kidney bean, white kidney bean, soybean and peanut.

Type of seed coats	***% Inhibition of BACE1***	***Concentration (mg/mL)***
Mung bean	72.74 ± 1.08 ^{a}	5
Black bean	53.78 ± 0.37 ^{b}	5
Red kidney bean	ND	5
White kidney bean	ND	10
Soybean	ND	10
Peanut	ND	5

All data were expressed by mean values ± standard deviation.
$^{a–b}$ showed significant difference ($p < 0.05$) within the same column using one–way ANOVA followed by Tukey's–b *post hoc* test.