Effect of Foxtail Millet Protein Hydrolysates on Lowering Blood Pressure in Spontaneously Hypertensive Rats

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Abstract

High blood pressure (BP) is one of the most important risk factors for human mortality. The potential antihypertensive effect of foxtail millet protein hydrolysates was investigated. Foxtail millet was fermented or extruded and then hydrolyzed to produce protein hydrolysates. Spontaneously hypertensive rats (SHRs) were administered with different foxtail millet protein hydrolysates for 4 weeks. The results showed that BP was lowered significantly and the raw and extruded samples were more effective than the fermented samples. The angiotensin-converting enzyme activity (ACE) and angiotensin II (Ang II) level in the treatment groups were significantly lowered. Thus, ingestion of foxtail millet protein hydrolysates, particularly the raw and extruded hydrolysates, may ameliorate hypertension. Foxtail millet protein could be used as antihypertensive supplements for controlling BP.

Introduction

High BP affects one third of the world population and is the leading risk element of cardiovascular diseases. ACE inhibitors play an important role in regulating BP in human body. In addition, oxidative stress may induce cardiovascular and renal damage with associated increase in BP. Furthermore, fermentation and extrusion processes are used as new approaches to enhance the ACE inhibitory peptide production in food. Foxtail millet had been confirmed to have beneficial functions including cholesterol-lowering and hepatic protection properties. Therefore, foxtail millet proteins, processed from fermentation and extrusion, may possess improved antihypertensive properties.

Objectives

To investigate the potential antihypertensive effect and possible mechanism of different protein hydrolysates derived from foxtail millet

Materials and Methods

Sample preparation

Foxtail millet (*Setaria italica* Beauv.) of Dongfangliang variety

Extrusion: Screw speed - 280 rpm; barrel temperature at the fourth phase - 175°C.

Fermentation: *Rhizopus oryzae*, ratio of 0.4%, 30°C for 48 h.

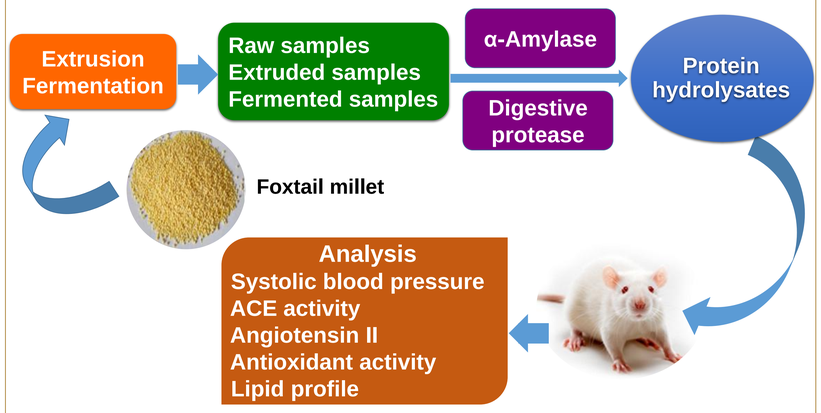
Hydrolysis: Freeze-drying and milling ➔ hydrolyzing by α-Amylase (30 U/g substrate) at 50°C for 2 h ➔ enzyme inactivation ➔ centrifugation ➔ freeze-drying supernatants. The samples were hydrolyzed by digestive protease (pepsin and pancreatin) to generate ACE inhibitory peptides.

Evaluation of antihypertensive effect

After acclimation, 30 eleven-week-old male spontaneously hypertensive rats (SHRs) were randomly divided into five groups, namely model control group, captopril group (2 mg/kg BW), and three foxtail millet protein hydrolysates groups including raw, extruded and fermented foxtail millet protein hydrolysates (RPH, EPH and FRPH) (200 mg peptide/kg BW).

Systolic BP was measured every week. After 4 weeks, the blood was collected and then all animals were sacrificed. The organs were immediately excised, weighed, and then frozen until analysis.

Materials and Methods (Continued)



Results

a. Systolic blood pressure

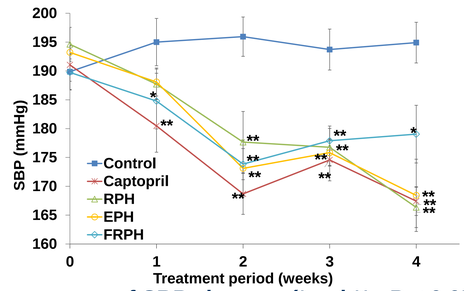


Fig.1 Time course of SBP changes (*and ** - P < 0.05 and P < 0.01)

After 4-week-treatment, SBP of all treatment groups significantly decreased ($p < 0.05$). SBP continued to decline in RPH, EPH and captopril groups, except that in FRPH group.

b. ACE activity and Angiotensin II level

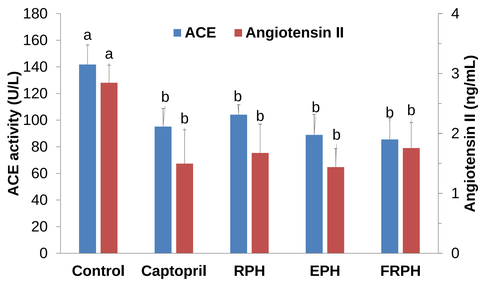


Fig.2 Effect of foxtail millet protein hydrolysates on serum ACE activity and Ang II level ($p < 0.05$)

The ACE activity and Ang II level of all treatment groups significantly decreased.

Results (Continued)

c. Body and organ weights

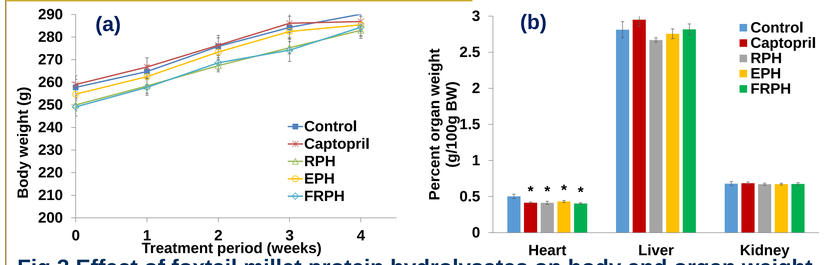


Fig.3 Effect of foxtail millet protein hydrolysates on body and organ weight

Body, percent kidney and liver weight were not significantly different during the experiment. However, heart weight of the treated SHRs was reduced significantly.

d. Antioxidant properties

Table 1. Effect of foxtail millet protein hydrolysates on oxidative stress marker in serum and liver (MDA, malondialdehvde; SOD, activity of superoxide dismutase; T-AOC, total antioxidant capacity)

	MDA		SOD		T-AOC	
	Serum (nmol/mL)	Liver (nmol/mg prot)	Serum (U/mL)	Liver (U/mg prot)	Serum (U/mL)	Liver (U/mg prot)
Control	14.43±3.87	2.09±0.40	264.04±72.96	130.24±29.86	3.91±0.31	0.42±0.06
Captopril	16.73±4.08	2.11±0.38	368.06±43.89*	147.21±16.79	4.35±0.54	0.38±0.13
RPH	14.43±3.66	1.89±0.45	289.73±57.19	113.86±29.9	3.27±0.70	0.31±0.05
EPH	14.16±4.09	1.83±0.27	254.36±32.34	110.08±19.83	6.39±1.33*	0.30±0.11
FRPH	18.84±4.01	2.51±0.54	330.16±69.08	154.06±9.66	3.62±0.70	0.46±0.11

A significant increase in serum T-AOC ability was observed in the group treated with EPH ($p < 0.05$). In addition, there was no significant difference in the MDA levels and SOD activity of different hydrolysates treated groups.

e. Lipid profiles

Table 2. Effect of foxtail millet protein hydrolysates on serum lipids (TC, total cholesterol; TG, triacylglycerol; HDL-C, high-density lipoprotein-cholesterol; LDL-C, low-density lipoprotein-cholesterol)

	Control	Captopril	RPH	EPH	FRPH
TC	1.6±0.17	1.71±0.26	1.68±0.11	1.62±0.21	1.48±0.14
TG	0.71±0.08	0.73±0.13	0.64±0.12	0.73±0.06	0.60±0.10
HDL-C	0.60±0.07	0.59±0.06	0.64±0.11	0.59±0.09	0.57±0.05
LDL-C	0.32±0.06	0.34±0.08	0.30±0.08	0.31±0.03	0.26±0.05
TG/HDL-C	2.26±0.53	2.25±0.66	2.21±0.16	2.35±0.19	2.37±0.27

There was no significant difference in lipid profiles ($p > 0.05$)

Conclusions

Administering rats with foxtail millet hydrolysates for 4 weeks significantly decreased SBP, ACE activity and angiotensin II level in all treatment groups than those in the control. Therefore, consumptions of raw, extruded and fermented foxtail millet protein hydrolysates are recommended for controlling hypertension and cardiovascular diseases without causing body weight or organ weight change.

Acknowledgements

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