ORIGINAL ARTICLE

Antihypertensive and Antihyperlipidemic Properties of Fagopyrum esculentum (Buckwheat) in Patients of Early Stage Hypertension

Nigar Naqvi[1*], Zeba Siddiqui[2], Arvind KM Srivastava[3] and Tabrez Jafar[4]

[1]Consultant Dietician, Era University, Lucknow, India.
[2]Department of Medicine, Era University, Lucknow, India.
[3]Department of Food & Nutrition, Era University, Lucknow, India.
[4]Department of Personalized & Molecular Medicine, Era University, Lucknow, India.

ABSTRACT Fagopyrum esculentum (Buckwheat) is proposed to have antihypertensive and lipid-lowering properties due to the presence of antioxidants and phytochemicals like quercetin, rutin, epicatechin-dimethylgallate. This study aimed to evaluate the therapeutic effects of buckwheat flour on newly diagnosed stage 1 and 2 adult hypertensive patients along with the standard of care treatment. Fagopyrum esculentum (Buckwheat) flour was given in the form of flatbread orally for 3 months to the study subjects. The control group was advised to follow lifestyle modification and antihypertensive medication only. Biochemical (lipid profile), anthropometric (weight), and clinical (blood pressure, pulse rate) parameters were recorded at baseline and after 2 weeks, 6 weeks, and 12 weeks for both the groups. At the end of 12 weeks; biochemical, anthropometric, and clinical parameters improved in the cases as compared to controls. Fagopyrum esculentum (Buckwheat) consumption is beneficial for hypertensive patients and has a favorable impact on lipids. Further studies with a large sample size are required to validate the findings.

Keywords: Anthropometric, Antihypertensive, Buckwheat, Hypolipidemic, Phytochemical, Clinical

Address for correspondence: Nigar Naqvi, Consultant Dietician, Era University, Lucknow, India. E-mail: nigarnaqvilko@gmail.com

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INTRODUCTION

Hypertension is the leading cause of cardiovascular disease and premature death worldwide. The prevalence of hypertension has increased, especially in low- and middle-income countries (LMICs). Estimates suggest that 31.1% of adults (1.39 billion) worldwide had hypertension in 2010. The prevalence of hypertension among adults was higher in LMICs (31.5%, 1.04 billion people) than in high-income countries (28.5%, 349 million people)[1]. During the last few decades, the prevalence of hypertension has increased drastically in India[2].

Blood pressure categories by American Heart Association define Stage 1 and Stage 2 hypertension as systolic between 130-139 or diastolic between 80-89 and Systolic at least 140 or diastolic at least 90 mm Hg respectively[3].

Hypertension should be treated to avoid long-term complications which can be life-threatening. Many classes of antihypertensive drugs are available but the importance of lifestyle and especially dietary modification can never be underestimated.

Buckwheat (Fagopyrum esculentum) is a herbaceous plant belonging to the Polygonaceae family that is easily available and economical. The nutritional profile of buckwheat is very good as it contains high biological value protein and balanced amino acid composition, fibers, vitamins B1 and B2, zinc, copper, manganese and selenium.100 gm of buckwheat provides 343 calories, 3.4 gm lipids, 71.5 gm of carbohydrates and 10 gm of fiber. Buckwheat flour has the highest protein (19.0 gm) content among all cereals[4].

Health benefits attributed to buckwheat as evidenced in many studies include cholesterol reduction, neuro-protection,

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anticancer, anti-inflammatory, and diabetic effects, and antihypertensive effects[5].

Antioxidant-rich diets have been associated with a lower incidence of cardiovascular disease, cancers, and age-related degenerative processes[6].

Flavonoids in Fagopyrum exhibit remarkable antioxidant and cardiac as well as cerebrovascular protective effects thus making it a valuable dietary supplement[7, 8].

Quercetin which is the major phytochemical in buckwheat has been shown to possess biological properties responsible for its beneficial effects on the cardiovascular system. It modifies eicosanoid biosynthesis (antiprostanoid and anti-inflammatory responses), protects low-density lipoprotein from oxidation (preventing atherosclerotic plaque formation), prevents platelet aggregation (antithrombic effects), and promotes relaxation of vascular smooth muscle (antihypertensive effect) [9]. In addition, oral administration of quercetin to spontaneously hypertensive rats has recently been shown to produce antihypertensive effects[10]. Buckwheat has been found to reduce plasma total cholesterol (TC), TC/HDL-C, and LDL-C/HDL-C in animal studies[11]. Human trials have not yielded much evidence yet. With the rapid increase in the disease burden of hypertension and dyslipidemia which act as a prelude to coronary artery disease, a search for natural strategies to aid pharmacological treatment is imminent. The present study was designed to evaluate the antihypertensive and lipid-lowering properties of buckwheat in newly diagnosed stage 1 and 2 hypertensive patients.

METHODOLOGY

Buckwheat grains were purchased from local markets of Lucknow, UP, were washed and dried for 2-3 days in sunlight, and subsequently powdered in a small-scale flour mill. The presence of larvae, grit, rodents, and weevils in buckwheat flour was checked by (FSSAI 2016 manual method) as well as the presence of synthetic color was tested[12].

The study was approved by the institutional ethics committee and informed consent was obtained from all study subjects. Newly diagnosed hypertensive patients according to ACA/AHA guidelines of hypertension belonging to stage 1 or 2 Hypertension>18 years of age of either sex were recruited from medicine outdoors of the hospital. Critically ill patients, patients of stage 3 HTN and beyond (hypertensive emergency or urgency), patients with food allergies, unable to take orally, patients with diabetes, renal disease, known cardiovascular disease, stroke, known cancer, or psychological disorders were excluded. Also excluded were pregnant and lactating women and secondary hypertension cases. A total of 126 subjects were included out of which 63 were cases and 63 were controls. Cases were given buckwheat supplement apart from the standard of care treatment whereas age and sex-matched controls received only antihypertensives and lifestyle modification.100 gm of Buckwheat flour in the form of flatbread (25 gm dough) twice a day was given to the cases group for a period of three months.BMI was taken at baseline and weight was measured at 2 weeks, 6 weeks, and 12 weeks. Blood pressure and pulse rate were also assessed on the same visits. Fasting blood samples were taken for lipid profile (Total cholesterol, Low-density lipoprotein (LDL), High-density lipoprotein (HDL), Triglycerides, and Very low-density lipoprotein (VLDL) level. For statistical analysis, the results are expressed as mean ± standard error. The unpaired t-test was used to compare parameters between groups and ANOVA was used for multivariate analysis. P-value<0.05 was considered to be statistically significant.

RESULTS

63 cases and 63 controls of newly diagnosed stage 1 and 2 hypertension who were prescribed antihypertensives along with lifestyle modification were compared in this study regarding changes in anthropometric, clinical, and biochemical parameters after supplementation with buckwheat flour for three months.

Table 1: Shows the Baseline Characteristics of Cases and Controls

Groups	Controls		Cases		Unpaired t-test	
	Mean	SD	Mean	SD	t-value	p-value
Age (years)	46.8	13.64	46.11	13.69	-0.28	0.778
Ht (m)	5.46	0.28	5.54	0.3	1.41	0.162
Weight baseline (kg)	72.07	6.88	72.24	6.24	0.15	0.884
Weight (3 month)	75.1	6.51	63.73	6.92	-9.41	**<0.001**
BMI Baseline	27.74	2.58	27.11	2.57	-1.36	0.177
BMI (3 month)	29.17	2.77	24.25	1.99	-11.38	<0.001

No significant differences in weight and BMI were present between control and case groups at baseline, but at 3 months, a significant reduction was observed in weight and subsequently BMI in cases ($p<0.001$).

Table 2 outlines the favorable impact of buckwheat supplementation on blood pressure in the cases group. From baseline to 2 weeks, no significant difference in mean SBP was found between the control and case group ($p>0.05$), but at 6 weeks, a slightly significant difference was observed ($p<0.05$), and at 12 weeks highly significant difference was observed where cases had lesser SBP(123.87+-4.35) than the control group(131.68+-7.42). However according to repeated measures ANOVA significant changes in SBP were found in both groups ($p<0.001$) and more in the case group(F case > F control).

From baseline to 2 weeks, no significant difference in mean DBP was found between the control and case group ($p>0.05$), but at 6 and 12 weeks, a significant difference was observed ($p<0.001$).

Diastolic BP was also found to be lower in the cases at the end of 6 and 12 weeks. However, according to repeated measures ANOVA significant changes in DBP were found in both groups ($p<0.001$) (Figures 1 and 2).

Table 2: Intergroup and Intragroup Comparison of Systolic and Diastolic Blood Pressure

	Parameter	Controls		Cases		t-value	p-value
		Mean	SD	Mean	SD		
Blood Pressure (Systolic) mm Hg	Baseline	148.87	10.99	149.03	10.33	-0.08	0.934
	2 weeks	143.33	9.87	142.13	9.33	0.75	0.482
	6 weeks	138.57	9.57	135.41	7.93	2.02	0.046
	12 weeks	131.68	7.42	123.87	4.35	7.2	**<0.001**
	F-value	111.46		254.95			
	p-value	**<0.001**		**<0.001**			
Blood Pressure (Diastolic) mm Hg	Baseline	100.37	7.32	100.21	7.22	0.12	0.903
	2 weeks	94.73	6.07	92.98	4.84	1.78	0.077
	6 weeks	90.32	4.95	87.62	4.48	3.21	**0.002**
	12 weeks	85.49	3.92	80.98	1.48	8.55	**<0.001**
	F-value	287.61		334.55			
	p-value	**<0.001**		**<0.001**			

Figure 1: Intergroup and Intragroup Comparison of Systolic Blood Pressure

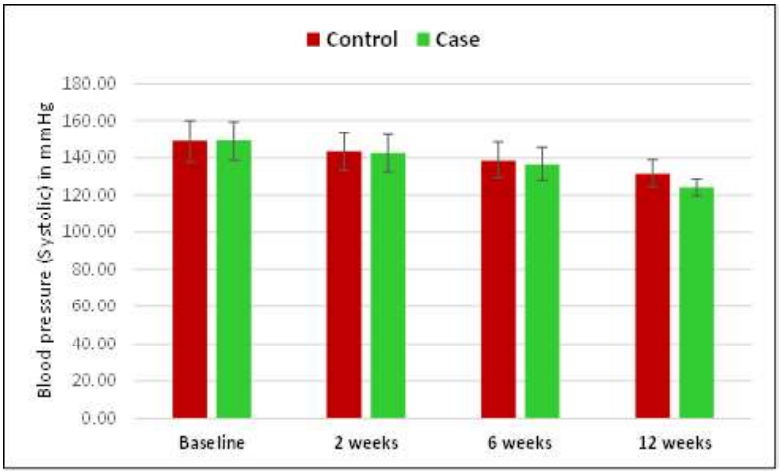


Figure 2: Intergroup and Intragroup Comparison of Diastolic Blood Pressure

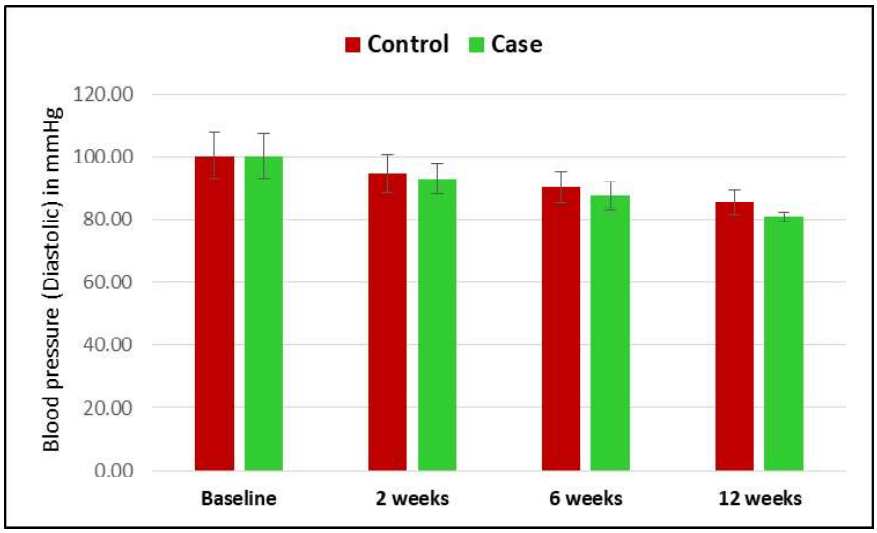


Table 3: Intergroup and Intragroup Comparison of Lipid Profile Level

	Parameter	Control		Case		t-value	p-value
		Mean	SD	Mean	SD		
HDL (mg/dl)	Baseline	42.78	3.7	42.24	2.8	0.92	0.357
	3 months	47.98	3.67	52.81	2.68	-8.44	<0.001
	t-value	17.64		24.33			
	p-value	<0.001		<0.001			
LDL (mg/dl)	Baseline	148.67	17.12	144.38	14.65	1.51	0.134
	3 months	130.7	17.68	113.54	13.72	6.09	<0.001
	t-value	-30.52		-15.68			
	p-value	<0.001		<0.001			
Serum cholesterol	Baseline	211.37	26.31	213.48	24.72	-0.46	0.643
	3 months	192.9	25.7	169.11	20.77	5.71	<0.001
	t-value	37.44		18.3			
	p-value	<0.001		<0.001			
Serum triglyceride (mg/dl)	Baseline	167.29	36.84	169.1	35.02	-0.28	0.778
	3 months	140.73	29.62	125.63	19.88	3.36	0.001
	t-value	-9.84		-13.9			
	p-value	<0.001		<0.001			
VLDL (mg/dl)	Baseline	27.49	3.34	27.24	4.54	0.36	0.721
	3 months	23.97	3.62	18.69	3.7	8.09	<0.001
	t-value	13.67		18.04			
	p-value	<0.001		<0.001			

Table 3 shows the effect of buckwheat on the case and control groups. According to the unpaired t-test, no significant difference in mean HDL, LDL, serum cholesterol, serum TG, and VLDL, was observed between the two groups but at 12 weeks cases had higher values of HDL and lower LDL, serum cholesterol, serum TG and VLDL. However, according to paired t-test significant changes in HDL, LDL, serum cholesterol, TG, and VLDL were found in both groups ($p<0.001$) (Figures 3-7).

Figure 3: Intergroup and Intra group Comparison of HDL

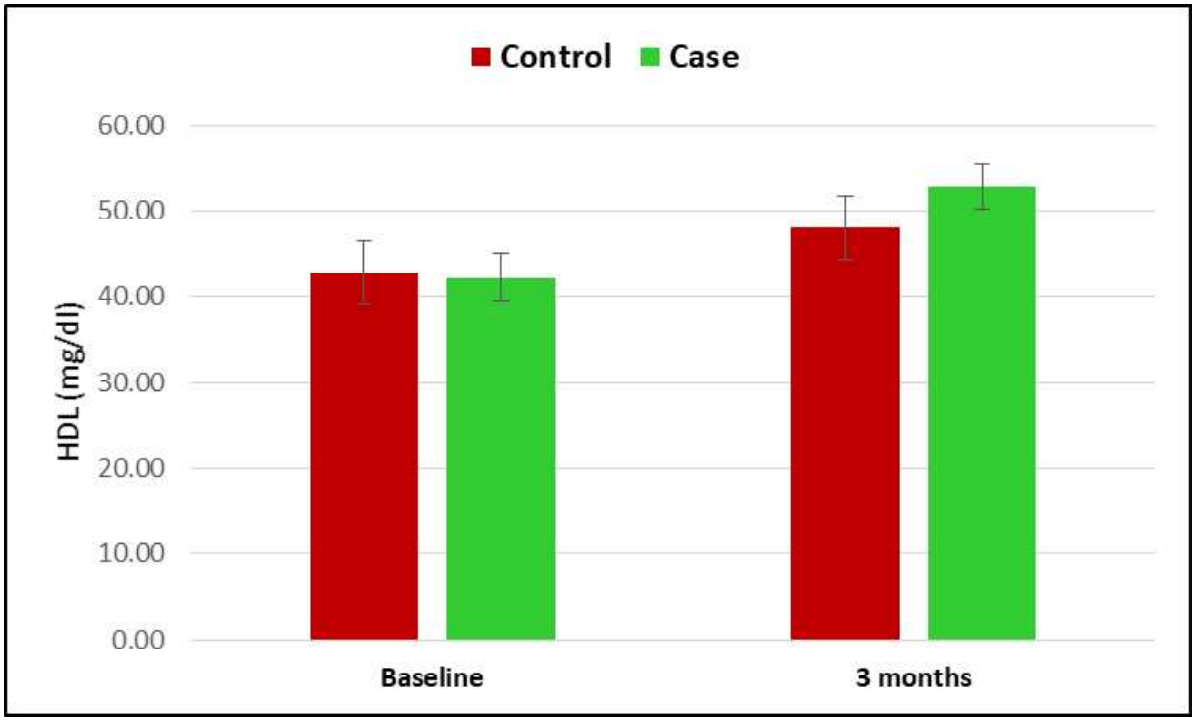


Figure 4: Intergroup and Intragroup Comparison of LDL

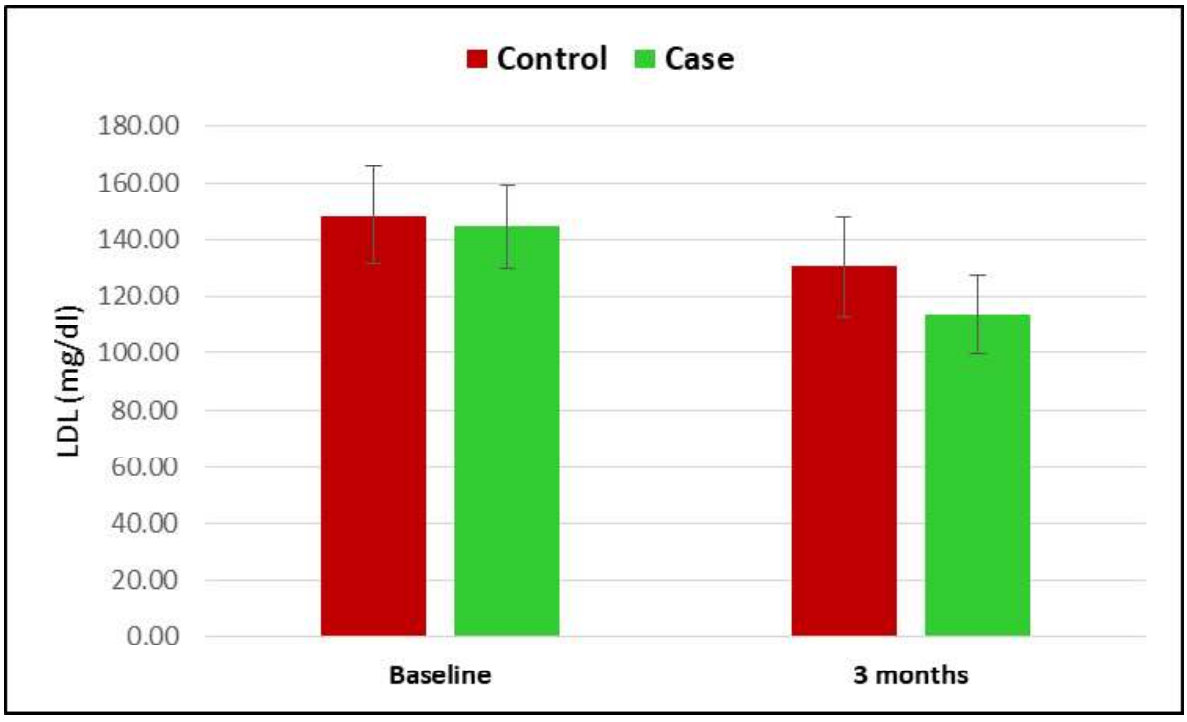


Figure 5: Intergroup and Intragroup Comparison of Serum Cholesterol

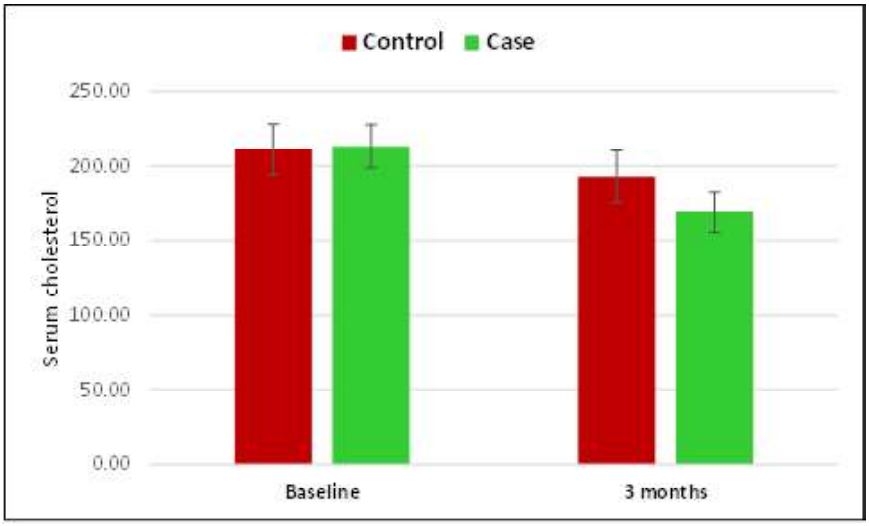


Figure 6: Intergroup and Intragroup Comparison Serum Triglycerides

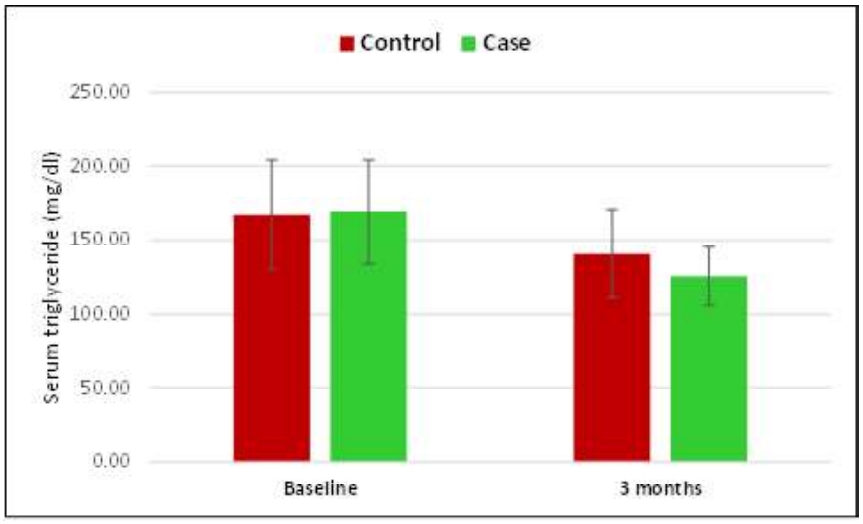
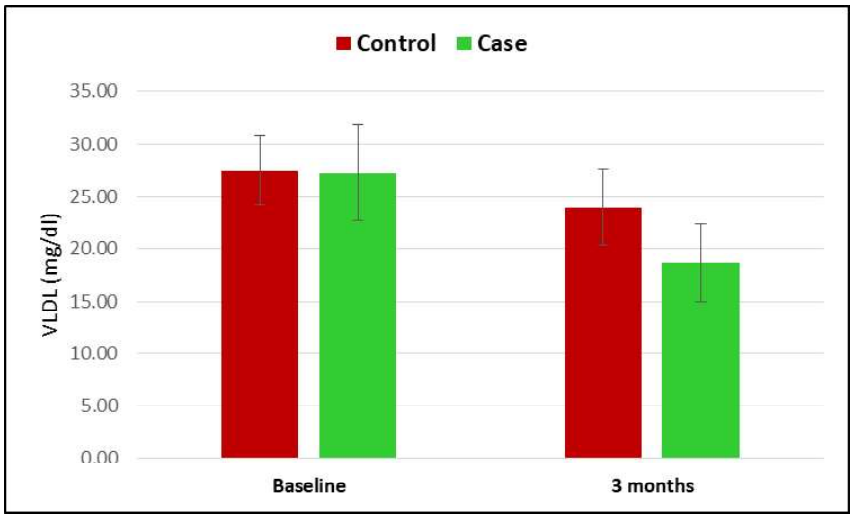


Figure 7: Intergroup and Intragroup Comparison of VLDL



DISCUSSION

The present study shows that regular consumption of Fagopyrum esculentum (buckwheat) has a favorable impact on the cardiovascular profile by reducing weight, systolic and diastolic blood pressures, and improving the lipid profile. Maja Đurendiæ et al. in an animal experiment on rats using buckwheat leaf and flower (BLF) mixture supplementation concluded that it significantly reduced weight, plasma lipid concentrations, and atherogenic index. They concluded that hypolipidemic, antiatherogenic, and antioxidative characteristics were due to high rutin content.[13]

He J *et al.* studied 850 Yi people, an ethnic minority in southwest China, reviewing the relationship between oats and buckwheat intake to cardiovascular disease. Buckwheat intake was associated with lower serum total cholesterol, low-density-lipoprotein cholesterol, and a higher ratio of HDL to total cholesterol.[14]

Mukoda *et al.* conducted an in vitro study on mice where they fed a standard diet supplemented with buckwheat hull extract for 14 days and found that LDL level was significantly reduced.[15]

Dae Won *et al.* in 2009 studied rats after treatment with (RBE) raw buckwheat extract and (GBE) germinated buckwheat extract for 5 weeks and found that the treatment with RBE and/or GBE significantly reduced oxidative damage in aortic endothelial cells by lowering nitrotyrosine immune reactivity. These results suggest that GBE has an antihypertensive effect and may protect arterial endothelial cells from oxidative stress. Systolic blood pressure was also reduced.[16]

Zhang *et al.* (2007) evaluated the effect of protein in buckwheat on 40 hamster rats with hypercholesterolemia and found that the buckwheat protein reduced cholesterol levels more than other grains.[17]

Wieslander G *et al.* (2011) performed a double-blind crossover in vivo study among female day-care center staff, consuming four common buckwheat cookies per day (16.5 mg rutin equivalents/day) for two weeks, while the second group consumed four Tartary buckwheat cookies per day (359.7 mg rutin equivalents/day). They concluded that intake of Tartary buckwheat cookies with a high level of the antioxidant rutin reduced levels of myeloperoxidase MPO, an indicator of inflammation. Moreover, intake of both types of buckwheat cookies lowered cholesterol levels.[18]

CONCLUSION

In vivo and in vitro studies suggest that buckwheat can regulate cholesterol levels and it can prevent the development of cardiovascular diseases. Our study confirms the findings of previous studies and shows that buckwheat has an antihypertensive effect in patients apart from its hypolipidemic properties. It may be attributed to the active compound quercetin in buckwheat possessing antioxidant properties and other phytochemicals. Further studies with a larger sample size are required to validate the efficacy of Fagopyrum esculentum in lowering atherogenic potential.

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