



The Effect of *Spirulina* Compounds on Insulin Sensitivity and Renal Function in Patients with Chronic Kidney Disease: A Randomized Double-Blind Placebo-Controlled Study

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BACKGROUND

Chronic Kidney disease (CKD) is considered a global public health problem, that causes high risk of mortality in cardiovascular diseases (CVDs), insulin resistance (IR) and uncontrolled hypertension is an early metabolic alteration in CKD patients. *Spirulina* is microalgae with nutritious ingredients and has potential effects on enhanced cardiovascular and metabolic health. However, the improvement in kidney function has not been clarified yet. Therefore, the aim of the present study was to investigate the effects of *Spirulina* extract compounds on metabolic parameters in CKD patients.

RESULTS

Table 1 Characteristic of subjects at week 0 and 12 of intervention¹

Variables	Group A (n = 10) ²		Group B (n = 12)		Group C (n = 14)		Group D (n = 14)	
	week 0	week 12	week 0	week 12	week 0	week 12	week 0	week 12
Age (years)	66.5 ± 12.1		65.8 ± 9.8		62.9 ± 10.7		68.1 ± 6.2	
Gender (F/M)	12 / 9		7 / 13		8 / 16		6 / 15	
Height (cm)	159.4 ± 5.0		164.9 ± 8.6		167.2 ± 8.8		166.2 ± 6.7	
Weight (kg)	66.4 ± 11.1	65.9 ± 8.4	68.1 ± 15.7	68.0 ± 15.8	68.8 ± 13.3	68.4 ± 13.8	75.1 ± 11.9	75.3 ± 12.4
BMI (kg/m ²)	26.1 ± 3.8	26.1 ± 3.5	24.9 ± 4.9	24.9 ± 4.9	24.6 ± 4.4	24.6 ± 4.6	27.1 ± 3.7	27.4 ± 4.3
CKD stage, n (%)								
2	2 (20.0%)		3 (25.0%)		2 (14.3%)		3 (21.4%)	
3a	4 (20.0%)		7 (58.3%)		8 (57.1%)		9 (64.3%)	
3b	4 (40.0%)		2 (16.7%)		4 (28.6%)		2 (14.3%)	

¹Values are presented as mean ± SD. BMI, body mass index; CKD, chronic kidney disease.

*Values are significantly different between week 0 and week 12 within the group; p < 0.05.

²Group A (placebo), group B (*spirulina* extract 250 mg/day), group C (*spirulina* extract 500 mg/day), group D (*spirulina* extract 500 mg + vitamin C 200 mg + glutathione 200mg/day).

Table 2 Renal function parameters of subjects at week 0 and 12 of intervention¹

Variables	Group A (n = 10) ²		Group B (n = 12)		Group C (n = 14)		Group D (n = 14)	
	week 0	week 12	week 0	week 12	week 0	week 12	week 0	week 12
BUN (mg/dL)	23.0 ± 6.2	24.1 ± 8.6	17.4 ± 5.2	22.5 ± 9.1	21.8 ± 5.5	20.8 ± 5.2	21.9 ± 13.6	20.8 ± 8.8
Creatinine (mg/dL)	1.4 ± 0.4	1.3 ± 0.4	1.3 ± 0.4	1.4 ± 0.4	1.4 ± 0.3	1.4 ± 0.4	1.3 ± 0.3	1.4 ± 0.6
eGFR (mL/min/1.73m ²)	50.7 ± 16.2	51.6 ± 16.1	54.0 ± 13.9	52.8 ± 17.5	49.2 ± 10.5	51.4 ± 14.1	57.2 ± 14.8	57.4 ± 17.7
Uric acid (mg/dL)	4.5 ± 2.2	4.2 ± 1.6	5.3 ± 1.8	5.6 ± 1.8	5.1 ± 1.3	5.1 ± 1.2	6.3 ± 2.4	5.6 ± 2.0
Albumin (g/dL)	4.0 ± 0.6	4.0 ± 0.6	4.2 ± 0.4	4.3 ± 0.6	4.2 ± 0.3	4.2 ± 0.4	4.2 ± 0.2	4.3 ± 0.2
UPCR (mg/g)	438.6 ± 580.3	325.8 ± 317.0	1183.6 ± 1773.3	1233.9 ± 1982.3	852.2 ± 1218.6	941.5 ± 1327.0	655.7 ± 1080.6	674.9 ± 945.0

¹Values are presented as mean ± SD. BUN, blood urea nitrogen; eGFR, estimated glomerular filtration rate; UPCR, urine protein creatinine ratio.

*Values are significantly different between week 0 and week 12 within the group; p < 0.05.

²Group A (placebo), group B (*spirulina* extract 250 mg/day), group C (*spirulina* extract 500 mg/day), group D (*spirulina* extract 500 mg + vitamin C 200 mg + glutathione 200 mg/day).

Table 3 Hematological parameters of subjects at week 0 and 12 of intervention¹

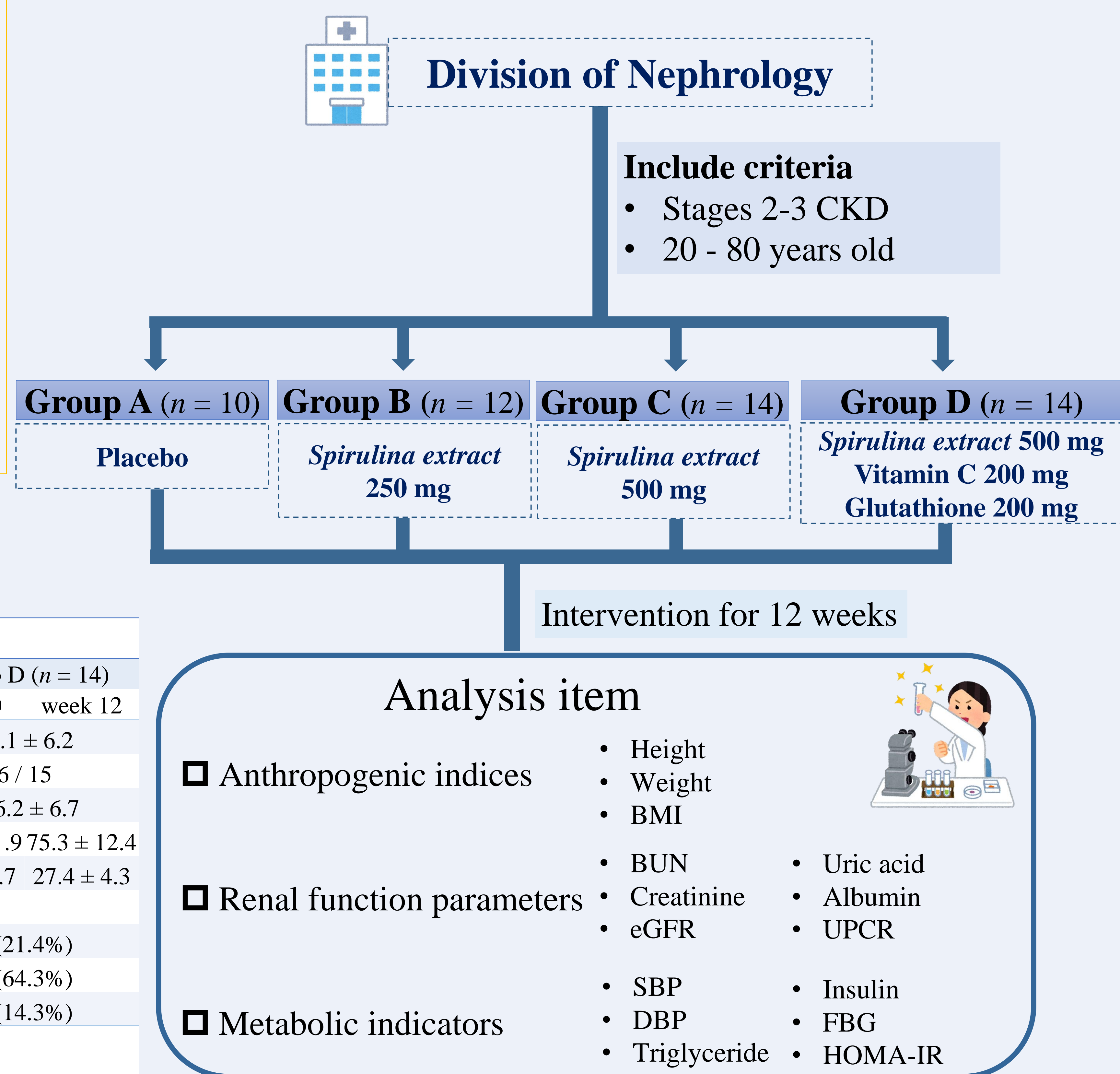
Variables	Group A (n = 10) ²		Group B (n = 12)		Group C (n = 14)		Group D (n = 14)	
	week 0	week 12	week 0	week 12	week 0	week 12	week 0	week 12
SBP (mmHg)	134.2 ± 23.7	141.7 ± 34.5	130.8 ± 18.0	126.1 ± 18.0	140.5 ± 21.8	139.2 ± 22.3	138.2 ± 16.0	137.1 ± 17.9
DBP (mmHg)	74.7 ± 15.8	77.3 ± 13.1	76.8 ± 11.3	71.7 ± 9.4*	83.7 ± 15.4	82.4 ± 15.4	83.1 ± 12.3	80.6 ± 11.4
Triglyceride (mg/dL)	102.3 ± 3.09	124.7 ± 67.7	157.9 ± 103.6	152.7 ± 111.1	135.3 ± 56.0	125.2 ± 53.2	178.3 ± 96.5	133.9 ± 55.1*
Insulin (μIU/mL)	10.0 ± 5.2	9.3 ± 5.1*	15.0 ± 12.1	13.7 ± 12.1	10.4 ± 9.9	8.8 ± 5.3	16.9 ± 14.5	12.2 ± 11.4*
FBG (mg/dL)	108.3 ± 35.4	99.8 ± 9.7	108.3 ± 19.3	109.5 ± 16.6	108.1 ± 29.7	110.3 ± 23.3	107 ± 22.5	106 ± 24.2
HOMA-IR	2.4 ± 1.4	2.4 ± 1.4	3.9 ± 3.1	3.7 ± 3.5	2.7 ± 2.4	2.4 ± 1.5	4.4 ± 3.6	3.3 ± 2.9*

¹Values are presented as mean ± SD. SBP, systolic blood pressure; DBP, diastolic blood pressure; FBG, fasting blood glucose; HOMA-IR, homeostasis model assessment-insulin resistance.

*Values are significantly different between week 0 and week 12 within the group; p < 0.05.

²Group A (placebo), group B (*spirulina* extract 250 mg/day), group C (*spirulina* extract 500 mg/day), group D (*spirulina* extract 500 mg + vitamin C 200 mg + glutathione 200 mg/day).

SUBJECT AND METHODS



STATISTICAL ANALYSIS

All data were expressed as mean ± standard deviation (SD) and statistically analyzed using SigmaPlot software (version 12.5, USA). Statistical significance of differences among different groups was evaluated by one way analysis of variance (ANOVA). Within group comparisons were analyzed with paired t-tests or Wilcoxon's signed rank tests. P < 0.05 was defined as statistically significant.

CONCLUSION

***Spirulina* extract compounds supplementation in CKD stage 2-3 patients had significant beneficial effects on triglyceride and blood glucose metabolism after the 12 week follow-up period.**