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Daily Consumption of the *Capparis spinosa* Reduces Some Atherogenic Indices in Patients with Non-alcoholic Fatty Liver Disease: A Randomized, Double-blind, Clinical Trial

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Abstract

Background: Despite a number of studies on the effects of complementary medicine products, the effects of caper fruit pickle (CFP), as Iranian traditional medicine (ITM), is not clear in non-alcoholic fatty liver disease (NAFLD).
Objectives: The current study aimed at assessing the effect of the CFP on anthropometric measures and some atherogenic indices in patients with non-alcoholic fatty liver disease (NAFLD).
Methods: A 12-week randomized, controlled, double-blind trial was conducted on 44 patients with NAFLD via block randomization method assigned to either the control (n = 22) or the CFP (n = 22) groups, from March to October 2016 in Zanjan city, Iran. The CFP group received 40 - 50 g of the CFP with daily meals. Before and after the treatment, anthropometric measures, serum lipoprotein ratios, and liver enzymes were assessed.
Results: After 12 weeks, weight and waist circumference significantly decreased both in the CFP ($P < 0.001$) and control groups ($P = 0.001$ and $P = 0.03$), respectively. Adjusted to the baseline measures, the a mean difference of alanine aminotransferase (ALT) ($P = 0.04$), low-density lipoprotein cholesterol/high-density lipoprotein cholesterol (LDL.C/HDL.C) ($P = 0.001$), triglyceride/HDL.C (TG/HDL.C) ($P < 0.001$) and total cholesterol/HDL.C (TC/HDL.C) ($P = 0.001$) decreased more significantly in the CFP than the control group at the end of the study.
Conclusions: The current study results suggested that daily consumption of the CFP for 12 weeks may potentially prevent cardiovascular complications in patients with NAFLD. Further studies are needed to confirm the findings.

Keywords: Atherogenic, Caper Fruit, Capparis, Fatty, Index, Non- Alcoholic, Pickle, Traditional Medicine

1. Background

Non-alcoholic fatty liver disease (NAFLD) is a multifactorial common metabolic disorder, which is an atherogenic condition due to liver manifestations of metabolic syndrome (1). Most patients have dyslipidemia, insulin resistance (IR), hypertension and visceral obesity (2). Regardless of body weight and other assessed risk factors, the prevalence of atherosclerosis in patients with NAFLD is high (3). Cardiovascular disease (CVD) is the common cause of death in patients with NAFLD (4). Steatosis and inflammation are 2 main factors for CVD occurrence in patients with NAFLD (5). Dyslipidemia, as a common risk factor of NAFLD and CVD, upregulates the transcription factor sterol regulatory element binding protein-1c (SREBP-1c). Insulin and SREBP-1c synergistically stimulate de-novo synthesis of genes involved in lipids metabolism. Furthermore, SREBP-1c inhibits oxidation of free fatty acids and leads to an increase in hepatic lipid droplets (6). By increasing the lipid droplets, especially as triglyceride (TG) form, liver initiates to form atherogenic lipid markers including high serum triglyceride (TG), small and dense low-density lipoprotein cholesterol (LDL.C), total cholesterol (TC), very low-density lipoprotein (VLDL), and elevated apolipoprotein B100 concentration, but decreases serum high-density lipoprotein cholesterol (HDL.C) levels. These alterations are the main predictors for CVD (7, 8). Although the con-

cise relationship between NAFLD and CVD is not clear, oxidative stress is considered as the main factor for initiation and progression of CVD in patients with NAFLD (9). Some antioxidants had beneficial effects on atherogenic indices under such conditions (10). Traditional medicine plants are used as complementary therapeutics in different countries (11). Recently, researches pay more attention to the positive role of medicinal plants to treat human chronic diseases (12). Caper (*Capparis spinosa*), as a member of Capparidaceae family, has health- promoting effects due to its valuable bioactive compounds. Then, different parts of this plant have various effects (13, 14). In some animal studies, a direct link was observed between caper fruit extract and the key pathogenic causes of NAFLD including IR, blood glucose, and lipid profile in diabetic cases (15). Reports showed the antioxidant, antimicrobial, anticancer, and hepatoprotective effects of *C. spinosa* (16). To the authors' best knowledge, there is no clinical trial to evaluate whether daily consumption of the caper fruit pickle (CFP) results in a greater beneficial effect on NAFLD. The current study aimed at comparing the effects of the CFP consumption on serum fasting glucose and lipid profile ratios, in patients with NAFLD after a 12-week intervention.

2. Methods

2.1. Design

The current randomized, double-blind, controlled trial aimed at assessing the effects of the CFP consumption on anthropometric measures, fasting blood glucose (FBS), homeostasis model assessment of IR (HOMA-IR), liver enzyme tests, and lipid profile in patients with NAFLD. The study was approved by the Ethical Committee of Tabriz University of Medical Sciences, Tabriz, Iran (TBZMED.REC.1394.650). All patients signed the informed consent forms before participation in the study participation. At the beginning of the study, baseline measures were recorded and eligible participants were randomly assigned via block randomization method, according to their body mass index (BMI), to the intervention and control groups. The current study was registered in the Iranian Registry of Clinical Trials (code no. IRCT2015122425686N1).

2.2. Participants

Patients with NAFLD were selected from March to October 2016 from the patients referred to the Metabolic Disease Research Center and Valie-Asr Hospital, Zanjan University of Medical Sciences, Zanjan, Iran. The inclusion criteria were age 12 - 80 years, BMI 25 - 35 kg/m^2, and willingness to adhere a new dietary regimen in order to improve fatty liver. The exclusion criteria were cigarette smoking, pregnancy, the history of labor, or planning pregnancy for the next six months, lactation, history of stroke, cirrhosis, viral hepatitis, liver obstructive diseases, heart disease, thyroid disorders, diabetes, dyslipidemia, intake of drugs for blood glucose or lipid control as well as anticoagulants that affect metabolism or body weight following a vegetarian or weight-loss diets up to two months before the beginning of study.

2.3. Intervention

Forty-four patients were randomly assigned to the CFP (n = 22) and control (n = 22) groups. Caper fruit was collected from Moghan, Pars Abad, Iran. A sample of whole plant was sent to the laboratory of the Herbarium Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran (herbarium code: 3969). At first, fruits were soaked in cool-boiled water for ten days. After boiling the fruits, they were soaked in home-made grape vinegar. All these procedures were done to improve the taste of the fruit. Microbial and fungal tests were conducted before distribution of the pickles. Patients were advised to receive 40 - 50 g of the CFP with their meals. All participants were similarly trained by a nutritionist for lifestyle changes. Compliance of the participants with the diet was assessed by telephone interview every week. Side effects were explained to all participants and followed up in each interview.

2.4. Measures

At the beginning, 24-hour dietary recall forms were completed and analyzed by the N4 software (Nutritionist 4, First Databank Division, Hearts Corporation). Body weight was measured using a calibrated scale to the nearest 100 g (Seca, Germany). Height and waist circumference (WC) were measured to the nearest 0.5 cm using a flexible tape measure (Seca). All measures, except height, were recorded at baseline and after 12 weeks of the intervention in the two groups.

Blood samples of all patients were taken from the antecubital vein after 10 - 12 hours fasting, at baseline and after 12 weeks for biochemical measurements. FBS, lipid profile, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were measured by the AutoAnalyzer. Serum insulin and high-sensitivity C-reactive protein (hs-CRP) level were measured by the enzyme-linked immunosorbent assay (ELISA) kit ((Biocompare Co, South San Francisco, CA 94080, USA). HOMA-IR: (fasting insulin (μU/m/L) x FBS (mM/L) /22.5 (17).

2.5. Sample Size and Statistical Analysis

Power of 80% with a two-sided test with type I error = 0.05 and mean difference of 25 IU/L for ALT levels were

considered to determine the sample size (18). The number of patients needed to reach this difference was 22 per group. Then, by computing 10% dropout, 25 patients were enrolled in each group.

All data were expressed as means ± standard deviation (SD). $P < 0.05$ was considered the level of significance. Normal distribution of the variables was checked by the Kolmogorov-Smirnov test. Independent samples t-test was used to assess differences in mean values of the studied items between the groups. The comparison of mean values of variables before and after the intervention in each group was examined by paired samples t-tests. Chi-square test was used to assess differences in categorical variables. Linear regression model was used to assess the effects of baseline parameters on the mean difference of measures from baseline to the end of the study.

2.6. Statistical Software

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, N.Y., USA).

3. Results

Dietary intake and physical activity did not indicate any significant differences between the two groups ($P > 0.05$). In the CFP and the control groups, 72.7%, and 59.1% of the participants, respectively, were female. Participants' gender had no significant difference between the two groups ($P > 0.05$). Mean age of participants was 40.32 ± 10.04 and 45 ± 10.03 years in the CFP and control groups, respectively, which had no significant difference between the two groups. As shown in Table 1, baseline levels of LDL.C/HDL.C, TC/HDL.C, non-HDL.C, and insulin were significantly higher in the CFP group than the control, but serum AST level was significantly higher in the control than the CFP group. Weight and WC significantly decreased in the CFP ($P < 0.001$ and $P < 0.001$) and the control groups ($P = 0.001$ and $P = 0.03$), after the 12-week intervention (Table 1).

In the CFP group, serum ALT, AST, non-HDL.C, as well as LDL.C/HDL.C, TG/HDL.C and TC/HDL.C significantly decreased at the end of the study ($P \leq 0.01$). In the controls, AST, ALT, non-HDL.C, LDL.C/HDL.C, and TC/HDL.C exhibited a significant decrease at the end of the study ($P \leq 0.01$).

Adjusted to the baseline measures, the mean difference of ALT ($P = 0.04$), LDL.C/HDL.C ($P = 0.001$), TG/HDL.C ($P < 0.001$) and TC/HDL.C ($P = 0.001$) decreased more significantly in the CFP compared with the control group at the end of the study (Table 1).

4. Discussion

Different studies assessed various protocols in patients with NAFLD, which had inconclusive results (19, 20). It is mentioned that chemical drugs may have destructive effects on health (12). Medicinal plants are the best therapeutic alternatives. They contain active compounds such as flavonoids and phenolic ingredients (21); but, more studies are needed to declare the effects and potential mechanisms of action of medicinal plants. To the authors' best knowledge, it was the first randomized feeding study to evaluate the beneficial effects of daily consumption of the CFP on atherogenic indices in patients with NAFLD.

The current study results showed that mean difference of serum ALT, as well as LDL.C/HDL.C, TG/HDL.C, and TC/HDL.C ratio decreased more significantly in the CFP than the control group from baseline up to the end, adjusted for the baseline measures.

According to the Iranian traditional medicine (ITM), some medicinal plants such as caper have beneficial effects on liver and spleen (22). The relationship between spleen and metabolic disorders, especially NAFLD is shown in previous studies (23, 24). Splenectomy is a therapeutic procedure in some clinical disorders, but recent studies reported that it may lead to the formation of atheroma lesions. Then, any complications in spleen function can result in various diseases such as atherosclerosis (25).

Previous studies showed that ratios of lipoproteins enriched by cholesterol ester (TC/HDL-C and LDL-C/HDL-C), as well as TG/HDL-C are strong predictors for IR and LDL particle diameter (small-dense LDL-C) and ultimately CVD (26).

Hepatoprotective effect of *C. spinosa* root bark was shown in the authors' previous study in which it decreased liver enzymes serum levels in a mice model of CCl4-induced liver toxicity (27). Also, the beneficial effects of caper fruit extract were assessed on the kidney and liver by measuring serum levels of creatinine, bilirubin, urea, uric acid, AST, ALT, and alkaline phosphatase (ALP). Also, histopathologic properties were compared between healthy and type 1 diabetic rats. Diabetes increased cellular necrosis in the liver and kidney of rats. These changes in the diabetic caper extract-treated group were at the lowest amounts. A decrease in serum levels of creatinine, liver enzymes, and other parameters were supporting the changes. The aqueous extract of *C. spinosa* inhibited gene expression of inflammatory markers including interleukin-6, tumor necrosis factor-alpha, and so on. The beneficial effects may be due to some components, especially saponins, flavonoids, and alkaloids (28). An animal study showed that these ingredients improved dyslipidemia, as hypercholesterolemia and hypertriglyceridemia (29). The notable protective activity of *C. spinosa* is men-

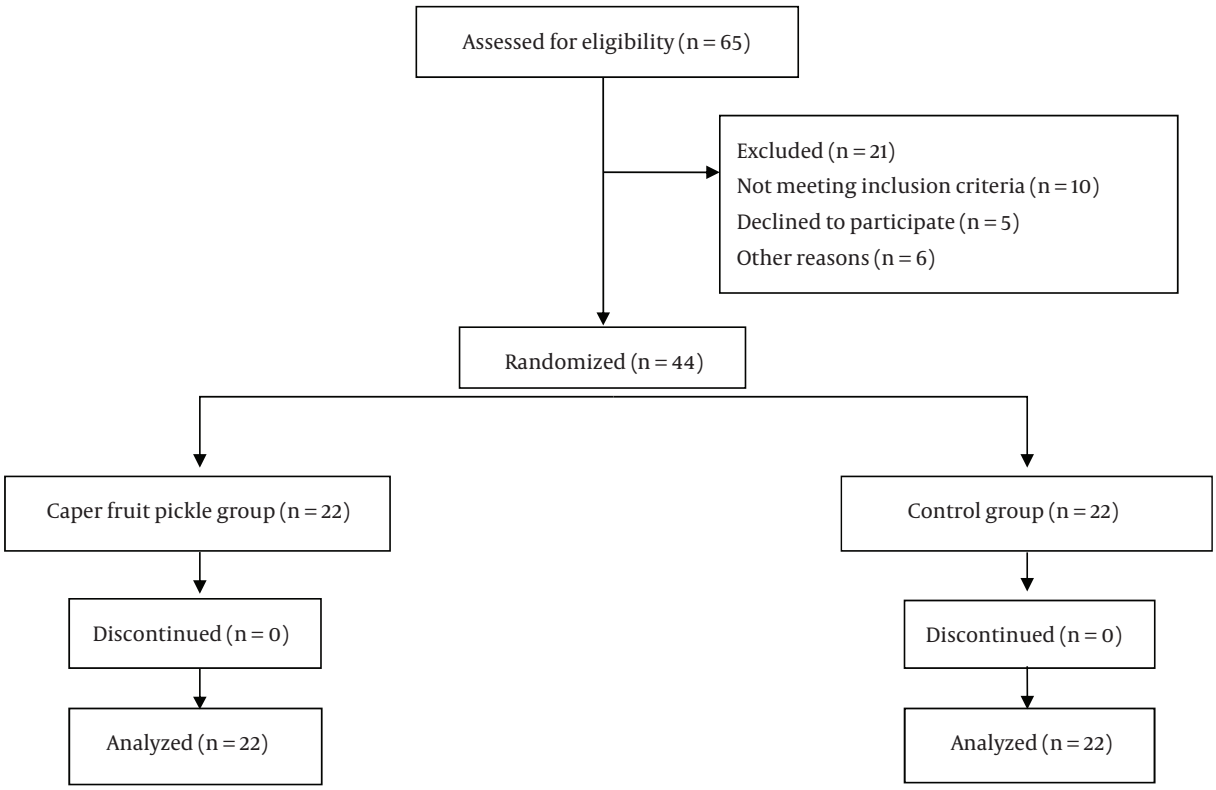

Figure 1. Consort flow

tioned against oxidative stress and reducing reactive oxygen species in systemic sclerosis dermal fibroblasts (30). On the other hand, a study showed that aqueous extract of *C. spinosa* had cholesterol decreasing effect by inhibiting its biosynthesis (31). Results of these studies were in accordance with those of the current study. Mean difference of lipid profile ratios including TG/HDL.C, LDL.C/HDL.C, and TC/HDL.C, as markers of cardiovascular exacerbate decreased after 12 weeks of the CFP consumption. Also, it is reported that lyophilized and methanolic extract of *C. spinosa* inhibits lipid peroxidation and has an antioxidant effect through phenolic compounds (30).

Hypoglycemic effect of the aqueous extract of *C. spinosa*, with no effects on plasma insulin concentrations, is reported in diabetic rats. In an animal study, serum levels of glucose decreased in type 1 diabetic cases following the consumption of *C. spinosa* extract (32). In the current study, mean difference of serum FBS, insulin, and HOMA-IR had no significant difference after 12 weeks of CFP consumption.

The current study seems to be the first of its kind in randomized, clinical trials assessing the effect of CFP consumption on some cardiovascular indices in the patients with NAFLD. Capper had more beneficial effects on ALT levels and lipid profile ratios. However, to obtain more conclusive results, similar studies with larger sample sizes over longer periods of time are recommended. There were some limitations to the current study results; most importantly NAFLD was diagnosed by biochemical and ultrasonographic findings in the current study patients, which was not possible to distinguish between simple fatty liver and NASH. Liver biopsy is the gold standard to diagnose NAFLD, but it is an invasive and expensive method. In future studies, precise control of dietary intake and physical activity level are suggested. Also, it is suggested that caper components be analyzed in future. More studies with the higher levels of these enzymes are needed to assess the effects of caper fruit on NAFLD progression. IR, inflammatory, and oxidative pathways are recommended to determine the involved signaling pathways.

References

1. Liu H, Lu HY. Nonalcoholic fatty liver disease and cardiovascular disease. *World J Gastroenterol*. 2014;**20**(26):8407–15. doi: 10.3748/wjg.v20.i26.8407. [PubMed: 25024598].

2. Hashizume H, Sato K, Yamazaki Y, Horiguchi N, Kakizaki S, Mori M. A prospective study of long-term outcomes in female patients with nonalcoholic steatohepatitis using age- and body mass index-matched cohorts. *Acta Med Okayama*. 2013;**67**(1):45–53. doi: 10.18926/AMO/49256. [PubMed: 23439508].
3. Blackett PR, Sanghera DK. Genetic determinants of cardiometabolic risk: a proposed model for phenotype association and interaction. *J Clin Lipidol*. 2013;**7**(1):65–81. doi: 10.1016/j.jacl.2012.04.079. [PubMed: 23351585].
4. Huang Y, Bi Y, Xu M, Ma Z, Xu Y, Wang T, et al. Nonalcoholic fatty liver disease is associated with atherosclerosis in middle-aged and elderly Chinese. *Arterioscler Thromb Vasc Biol*. 2012;**32**(9):2321–6. doi: 10.1161/ATVBAHA.112.252957. [PubMed: 22814750].
5. Feitosa MF, Reiner AP, Wojczynski MK, Graff M, North KE, Carr JJ, et al. Sex-influenced association of nonalcoholic fatty liver disease with coronary heart disease. *Atherosclerosis*. 2013;**227**(2):420–4. doi: 10.1016/j.atherosclerosis.2013.01.013. [PubMed: 23390892].
6. Dogru T, Genc H, Tapan S, Ercin CN, Ors F, Aslan F, et al. Elevated asymmetric dimethylarginine in plasma: an early marker for endothelial dysfunction in non-alcoholic fatty liver disease? *Diabetes Res Clin Pract*. 2012;**96**(1):47–52. doi: 10.1016/j.diabres.2011.11.022. [PubMed: 22189171].
7. Alkhouri N, Kistangari G, Campbell C, Lopez R, Zein NN, Feldstein AE. Mean platelet volume as a marker of increased cardiovascular risk in patients with nonalcoholic steatohepatitis. *Hepatology*. 2012;**55**(1):331. doi: 10.1002/hep.24721. [PubMed: 21969091].
8. Gawrieh S, Baye TM, Carless M, Wallace J, Komorowski R, Kleiner DE, et al. Hepatic gene networks in morbidly obese patients with nonalcoholic fatty liver disease. *Obes Surg*. 2010;**20**(12):1698–709. doi: 10.1007/s11695-010-0171-6. [PubMed: 20473581].
9. Cakir E, Ozbek M, Colak N, Cakal E, Delibasi T. Is NAFLD an independent risk factor for increased IMT in T2DM? *Minerva Endocrinol*. 2012;**37**(2):187–93. [PubMed: 22691891].
10. Shidfar F, Jazayeri S, Mousavi SN, Malek M, Hosseini AF, Khoshpey B. Does Supplementation with Royal Jelly Improve Oxidative Stress and Insulin Resistance in Type 2 Diabetic Patients? *Iran J Public Health*. 2015;**44**(6):797–803. [PubMed: 26258092].
11. Patel D, Prasad S, Kumar R, Hemalatha S. An overview on antidiabetic medicinal plants having insulin mimetic property. *Asia Pacific J Tropic Biomed*. 2012;**2**(4):320–30.
12. Gurney SM, Scott KS, Kacinko SL, Presley BC, Logan BK. Pharmacology, Toxicology, and Adverse Effects of Synthetic Cannabinoid Drugs. *Forensic Sci Rev*. 2014;**26**(1):53–78. [PubMed: 26226970].
13. Yang T, Liu YQ, Wang CH, Wang ZT. [Advances on investigation of chemical constituents, pharmacological activities and clinical applications of Capparis spinosa]. *Zhongguo Zhong Yao Za Zhi*. 2008;**33**(21):2453–8. [PubMed: 19149246].
14. Tlili N, Mejri H, Anouer F, Saadaoui E, Khaldi A, Nasri N. Phenolic profile and antioxidant activity of Capparis spinosa seeds harvested from different wild habitats. *Indust Crop Product*. 2015;**76**:930–5.
15. Kazemian M, Abad M, Haeri MR, Ebrahimi M, Heidari R. Anti-diabetic effect of Capparis spinosa L. root extract in diabetic rats. *Avicenna J Phytomed*. 2015;**5**(4):325–32. [PubMed: 26445712].
16. Gull T, Anwar F, Sultana B, Alcayde MAC, Nouman W. Capparis species: A potential source of bioactives and high-value components: A review. *Indust Crop Product*. 2015;**67**:81–96.
17. Wallace TM, Levy JC, Matthews DR. Use and abuse of HOMA modeling. *Diabetes Care*. 2004;**27**(6):1487–95. [PubMed: 15161807].
18. Eslamparast T, Poustchi H, Zamani F, Sharafkhah M, Malekzadeh R, Hekmatdoost A. Synbiotic supplementation in nonalcoholic fatty liver disease: a randomized, double-blind, placebo-controlled pilot study. *Am J Clin Nutr*. 2014;**99**(3):535–42. doi: 10.3945/ajcn.113.068890. [PubMed: 24401715].
19. Lorvand Amiri H, Agah S, Mousavi SN, Hosseini AF, Shidfar F. Regression of Non-Alcoholic Fatty Liver by Vitamin D Supplement: A Double-Blind Randomized Controlled Clinical Trial. *Arch Iran Med*. 2016;**19**(9):631–8. [PubMed: 27631178].
20. Mousavi SN, Faghihi A, Motaghinejad M, Shiasi M, Imanparast F, Amiri HL. Zinc and Selenium Co-supplementation Reduces Some Lipid Peroxidation and Angiogenesis Markers in a Rat Model of NAFLD-Fed High Fat Diet. *Biolog Trac Element Res*. 2017:1–8. Persian.
21. Schulz V. Safety of St. John's Wort extract compared to synthetic antidepressants. *Phytomedicine*. 2006;**13**(3):199–204. doi: 10.1016/j.phymed.2005.07.005. [PubMed: 16428030].
22. Aveccena. *Qanoon fi teb (Fundamentals of Medicines - Diseases - Pharmaceuticals and Industry)*. Beirut: Dar ol torath ol arabieh; 2005.
23. Emtiazy M, Choopani R, Khodadoost M, Tansaz M, Nazem E. Atheroprotector role of the spleen based on the teaching of Avicenna (Ibn Sina). *Int J Cardiol*. 2013;**167**(1):26–8. doi: 10.1016/j.ijcard.2012.06.020. [PubMed: 22726399].
24. Tarantino G, Scalera A, Finelli C. Liver-spleen axis: intersection between immunity, infections and metabolism. *World J Gastroenterol*. 2013;**19**(23):3534–42. doi: 10.3748/wjg.v19.i23.3534. [PubMed: 23801854].
25. Robinette CD, Fraumeni J. Splenectomy and subsequent mortality in veterans of the 1939-45 war. *Lancet*. 1977;**310**(8029):127–9.
26. Quijada Z, Paoli M, Zerpa Y, Camacho N, Cichetti R, Villarroel V, et al. The triglyceride/HDL-cholesterol ratio as a marker of cardiovascular risk in obese children; association with traditional and emergent risk factors. *Pediatr Diabetes*. 2008;**9**(5):464–71. doi: 10.1111/j.1399-5448.2008.00406.x. [PubMed: 18507788].
27. Aghel N, Rashidi I, Mombeini A. Hepatoprotective activity of Capparis spinosa root bark against CCl4 induced hepatic damage in mice. *Iran J Pharmaceutic Res*. 2010:285–90.
28. El Azhary K, Tahiri Jouti N, El Khachibi M, Moutia M, Tabyaoui I, El Hou A, et al. Anti-inflammatory potential of Capparis spinosa L. in vivo in mice through inhibition of cell infiltration and cytokine gene expression. *BMC Complement Altern Med*. 2017;**17**(1):81. doi: 10.1186/s12906-017-1569-7. [PubMed: 28143472].
29. Anila L, Vijayalakshmi N. Flavonoids from Emblica officinalis and Mangifera indica—effectiveness for dyslipidemia. *J Ethnopharmacol*. 2002;**79**(1):81–7.
30. Germano MP, De Pasquale R, D'Angelo V, Catania S, Silvari V, Costa C. Evaluation of extracts and isolated fraction from Capparis spinosa L. buds as an antioxidant source. *J Agric Food Chem*. 2002;**50**(5):1168–71. [PubMed: 11853498].
31. Eddouks M, Lemhadri A, Michel JB. Hypolipidemic activity of aqueous extract of Capparis spinosa L. in normal and diabetic rats. *J Ethnopharmacol*. 2005;**98**(3):345–50. doi: 10.1016/j.jep.2005.01.053. [PubMed: 15814271].
32. Eddouks M, Lemhadri A, Hebi M, El Hidani A, Zeggwagh NA, El Bouhali B, et al. Capparis spinosa L. aqueous extract evokes antidiabetic effect in streptozotocin-induced diabetic mice. *Avicenna J Phytomed*. 2017;**7**(2):191–8. [PubMed: 28348974].

Table 1. Anthropometric and Biochemical Characteristics at in the Study Groups[a]

Variable	Control (N = 22), Mean ± SE	CFP (N = 22), Mean ± SE	P Value
Weight, kg			
Baseline	81.3 ± 2.9	81.3 ± 2.1	0.9[b]
12 Weeks	79.8 ± 2.8	78.9 ± 2.1	0.8[b]
Treatment effect	-1.5 ± 0.4	-2.4 ± 0.27	0.09[c]
WC, cm			
Baseline	102.6 ± 1.3	104.2 ± 2.4	0.5
12 Weeks	100.3 ± 1.3	100.9 ± 2.4	0.8
Treatment effect	-2.3 ± 1	-3.2 ± 0.5	0.4
ALT, U/L			
Baseline	71.4 ± 2.1	73.2 ± 8.3	0.84
12 Weeks	64.02 ± 2.6	44 ± 6.6	0.007
Treatment effect	-7.4 ± 1.3	-29.2 ± 4.6	0.04
AST, U/L			
Baseline	68.3 ± 2.2	40.2 ± 3.01	< 0.001
12 Weeks	60.2 ± 3	28.3 ± 2.3	< 0.001
Treatment effect	-8 ± 1.8	-11.9 ± 2.2	0.9
LDL.C/HDL.C			
Baseline	1.8 ± 0.24	3 ± 0.2	0.001
12 Weeks	1.5 ± 0.2	2.6 ± 0.16	< 0.001
Treatment effect	-0.31 ± 0.08	-0.42 ± 0.14	0.001
TG/HDL.C			
Baseline	5.2 ± 0.47	5.5 ± 0.6	0.7
12 Weeks	5.2 ± 0.64	4.3 ± 0.36	0.3
Treatment effect	-0.03 ± 0.2	-1.1 ± 0.4	< 0.001
TC/HDL.C			
Baseline	3.8 ± 0.23	5.1 ± 0.26	0.001
12 Weeks	3.5 ± 22	4.6 ± 0.24	0.003
Treatment effect	-0.32 ± 0.12	-0.57 ± 0.2	0.001
Non-HDL.C, mg/dL			
Baseline	122.7 ± 8.1	154.6 ± 9.2	0.01
12 Weeks	108.4 ± 7.9	140.6 ± 8.9	0.01
Treatment effect	-14.3 ± 2.4	-14 ± 5.8	0.32
FBS, mg/dL			
Baseline	100.7 ± 5.6	90 ± 2.2	0.08
12 Weeks	97.8 ± 5.5	87.1 ± 2.1	0.07
Treatment effect	-2.8 ± 0.6	-2.8 ± 2.07	0.37
Insulin, μU/mL			
Baseline	10.8 ± 0.72	14.5 ± 1.1	0.009
12 Weeks	9.9 ± 0.7	12.7 ± .8	0.15
Treatment effect	-0.92 ± 0.17	-1.8 ± 1.6	0.44
HOMA-IR			
Baseline	2.7 ± 0.23	3.3 ± 0.29	0.13
12 Weeks	2.4 ± 0.2	2.8 ± 0.45	0.4
Treatment effect	-0.3 ± 0.05	-0.47 ± 0.46	0.4
hs-CRP, mg/dL			
Baseline	4.2 ± 0.6	3.2 ± 1.05	0.43
12 Weeks	3.1 ± 0.5	2.3 ± 0.6	0.3
Treatment effect	-1.02 ± 0.27	-0.91 ± 0.88	0.74

Abbreviations: ALT, alanine transaminase; AST, aspartate transaminase; CFP, caper fruit pickle; hs-CRP, high-sensitive C-reactive protein; TC, total cholesterol; TG, triglycerides; WC, waist circumference

[a] Values as means ± SE; P < 0.05 was considered as significant

[b] P values are related to the differences between the groups after 12 week of intervention evaluated by a linear regression model with baseline values as covariate

[c] P values are related to the differences between the two studied groups; evaluated by independent samples t test