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Cranberry Supplementation Modulates Liver Cardiometabolic and Enzymes Profiles in NAFLD: Evidence from a Randomized Trial

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Abstract

The present study assessed whether cranberry supplementation influences liver enzyme activity, hepatic fat content, and cardiometabolic risk parameters in patients diagnosed with non-alcoholic fatty liver disease (NAFLD). This randomized, parallel-group clinical trial included 110 individuals diagnosed with NAFLD, who were assigned to either a 144 mg cranberry supplement or a placebo for a duration of six months. The study primarily evaluated effects on liver enzymes, glycemic control, and lipid metabolism. The trial involved 46 participants receiving the supplement and 48 receiving placebo. Participants had an average age of 43.16 years (SD 11.08). Post-treatment liver enzyme levels showed no notable differences between the two groups. In contrast, the supplementation group exhibited significantly reduced average levels of total cholesterol ($p < 0.001$) and triglycerides ($p = 0.01$) compared to the placebo group. At study completion, average insulin concentrations and HOMA-IR values were also markedly lower in the group receiving cranberry supplementation than in the placebo group. Furthermore, a significantly higher number of participants in the cranberry group achieved an improvement in liver steatosis grade relative to the control group. The findings of this study indicate that cranberry supplementation may improve certain lipid parameters, reduce insulin resistance, and positively influence hepatic steatosis in patients with NAFLD.

Keywords: NAFLD, Cranberry, Liver enzymes, Cardiometabolic

Introduction

Nonalcoholic fatty liver disease (NAFLD) is characterized by an abnormal accumulation of fat in the liver that occurs independently of alcohol consumption, drug use, or viral hepatitis [1]. Globally, NAFLD affects approximately one-quarter of the population, with particularly high prevalence reported in Middle Eastern countries [2]. This condition is linked to multiple comorbidities, including cardiovascular and kidney diseases, highlighting its systemic impact [3].

Due to its growing health burden, considerable research efforts have been directed toward identifying effective strategies for NAFLD prevention and management [4]. A range of approaches—including lifestyle interventions, pharmacotherapy, vitamin supplementation, phlebotomy, and surgical procedures—has been suggested for patients with NAFLD [5]. However, many of these strategies demonstrate limited efficacy, and invasive interventions, such as surgery, may carry additional risks. Thus, safer and more effective therapeutic options remain a priority.

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In recent years, interest has increased in the potential of herbal therapies for NAFLD management [6]. Evidence suggests that certain herbal treatments, particularly when combined with lifestyle modification, may improve clinical outcomes in NAFLD patients [6]. Cranberry (Vaccinium macrocarpon), a fruit rich in polyphenolic compounds, has shown promise in preclinical studies for improving liver enzyme activity and reducing hepatic fat accumulation [7–9]. Human studies have evaluated cranberry in capsule form (240–1500 mg/day) [9–12] or as juice (240–750 ml/day) [13–19] for effects on cardiometabolic risk factors, producing mixed results. Some trials have reported beneficial impacts on total cholesterol LDL-C [11], (TC) [11], HDL-C [19], blood pressure [15] and fasting plasma glucose (FPG) [16].

Conversely, a recent systematic review and meta-analysis found that while cranberry supplementation significantly reduced blood pressure and body weight in patients with diabetes and metabolic syndrome, it had no significant effect on glycemic indices or lipid profiles [20]. To date, only one study has specifically investigated cranberry supplementation in NAFLD patients [21]. Hormoznejad *et al*. administered 288 mg of cranberry daily for three months, observing significant reductions in alanine aminotransferase (ALT) and insulin levels compared to placebo. However, the study's short duration highlighted the need for longer-term trials in this population [21].

Given cranberry's high antioxidant capacity and the role of oxidative stress in NAFLD pathogenesis, we hypothesized that cranberry supplementation combined with a hypocaloric diet could improve liver function, metabolic parameters, and hepatic steatosis. Therefore, this clinical trial was conducted to evaluate the effects of cranberry supplementation on serum liver enzymes, hepatic fat content, and glycemic and lipid profiles in patients with NAFLD.

Materials and Methods

Patient

This study was a triple-blind randomized and parallel-designed controlled trial. Patients with a prior diagnosis of NAFLD, referred to the liver disease clinic of Imam Reza Educational Hospital, Tabriz, Iran, starting in August 2020, were considered for enrollment. Diagnosis was confirmed via liver ultrasonography by experienced gastroenterologists. Eligible participants were adults aged 18 years or older. Exclusion criteria included pregnancy or breastfeeding, diabetes, other liver disorders, heart, kidney or pulmonary failure, alcohol consumption, and use of antioxidant or vitamin supplements other than vitamin E.

A total of 110 participants were enrolled. Randomization was performed using a computer-generated chart via GraphPad QuickCalcs, and allocation was concealed using sequentially numbered, sealed envelopes. A researcher not involved in other aspects of the study managed randomization. All participants received a hypocaloric diet providing 500 kcal less than estimated vitamin E and energy requirements supplementation.

Participants in the intervention group (n = 55) received a daily cranberry capsule (144 mg), while those in the placebo group (n = 55) received an identical placebo for six months. Capsules were to be taken after lunch. Participants received detailed instructions on trial procedures and periodic follow-up phone calls to ensure adherence.

Cranberry capsules and placebos were obtained from Shari Company, Iran. Each cranberry capsule contained 144 mg Vaccinium macrocarpon (equivalent to 13 g dried fruit), while placebos matched the base formulation without active ingredients. Both were identically packaged and labeled as A or B by a researcher uninvolved in trial procedures. Patients, outcome assessors, and statisticians remained blinded to group allocation.

All participants provided written informed consent. The study protocol was approved by the Ethics Committee of Tabriz University of Medical Sciences (Ethics code: IR.TBZMED.REC.1399.090) and conducted according to institutional ethical guidelines. The trial was registered with the Iranian Registry of Clinical Trials (Identifier: IRCT20200725048200N1; first registration date: 11.8.2020). Sample size calculations, based on previous research assessing the effects of cranberry juice on glycemic indices [15], assumed a two-sided significance level of 5%, 80% power, and equal allocation, requiring 37 participants per group. To account for potential dropouts, 55 participants were recruited per arm.

Measurements

Participants attended monthly follow-up visits during the six-month intervention to monitor adherence to both the supplementation regimen and recommended lifestyle changes. Individuals who consumed over 80% of their assigned capsules were considered compliant with the intervention.

Outcome assessment

The study's primary outcomes included serum lipid levels—total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C)—glycemic parameters including fasting blood sugar (FBS) and insulin, as well as liver enzymes, specifically alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP).

Anthropometric data, such as height and weight, were measured at baseline and at the end of the study. Height was recorded to the nearest 0.1 cm using a standard tape measure, and weight was determined with a Seca digital scale to the nearest 0.1 kg. Body mass index (BMI) was then calculated as weight in kilograms divided by the square of height in meters (kg/m²).

Following a 10-hour overnight fast, blood samples were collected from all participants. Laboratory analyses were carried out in the same facility using standardized methods. Colorimetric assays (Parsazmoun, Tehran, Iran) were employed to measure liver enzymes, TG, FBS, HDL-C and TC, while serum insulin was quantified using ELISA (Monobind, USA). LDL-C values were calculated using the Friedewald equation. Insulin resistance was estimated using the HOMA-IR formula as described by Gayoso-Diz *et al.*: HOMA-IR = fasting glucose (mmol/L) × fasting insulin (IU/mL) ÷ 22.5.

Statistical analysis

Statistical analyses were conducted with SPSS version 16. The Kolmogorov-Smirnov test assessed the distribution of continuous variables. Descriptive statistics were presented as mean ± SD for continuous data and as frequency (percentage) for categorical data. Within-group comparisons of pre- and post-intervention measures were performed using paired-sample t-tests, while between-group differences were analyzed with independent t-tests or chi-square tests, as appropriate. Post-intervention outcomes were also examined using one-way ANCOVA, adjusting for sex, age, baseline values and BMI. A two-sided p-value < 0.05 was considered statistically significant.

Results and Discussion

Out of the 110 patients enrolled in the trial, nine participants from the cranberry supplementation group and seven from the placebo group did not complete the study. Therefore, the final analysis included 94 patients: 48 in the placebo group and 46 in the cranberry group **(Figure 1).**

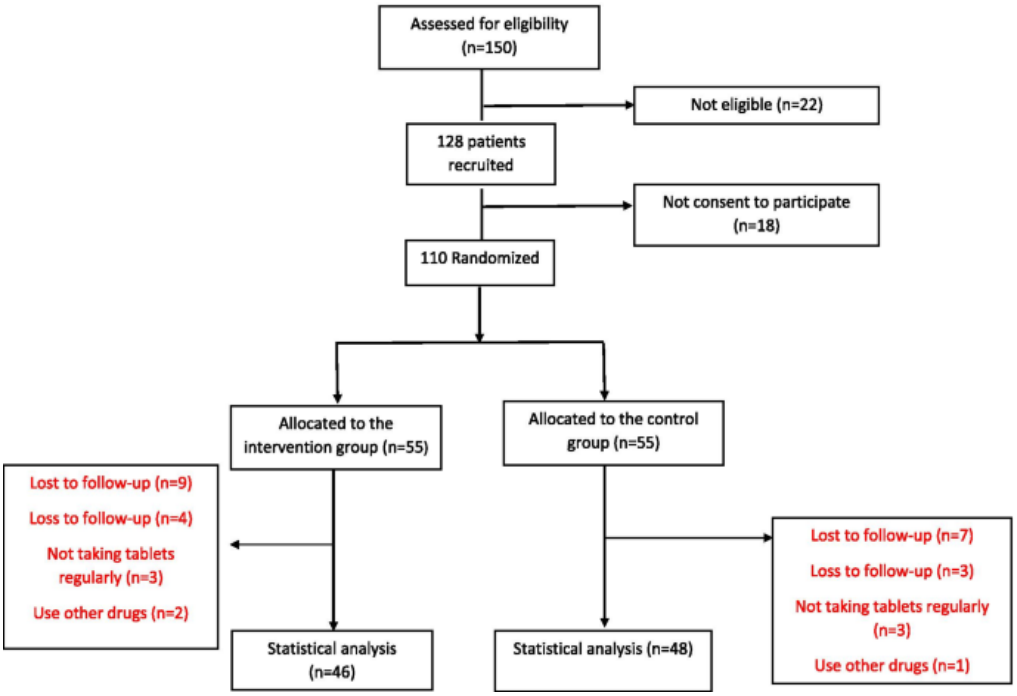

Figure 1. Flow diagram of participant recruitment and study analysis.

The participants had a mean (SD) age of 43.16 (11.08) years, with 47.9% being male. Most of the study population (76.6%) were classified as overweight or obese. There were no significant differences in baseline demographic or clinical characteristics between the cranberry and placebo groups **(Table 1).**

Table 1. Baseline characteristics of study participants

Variable	Cranberry Group (n = 46)	Placebo Group (n = 48)	p-value
Age (years, mean ± SD)	43.20 ± 11.30	43.13 ± 10.98	0.97
Sex, n (%) male / female	22 (47.8%) / 24 (52.2%)	23 (47.9%) / 25 (52.1%)	0.99
Body Mass Index (BMI, kg/m², mean ± SD)	28.17 ± 4.99	28.63 ± 4.15	0.63
Systolic Blood Pressure (SBP, mmHg, mean ± SD)	127.39 ± 24.61	124.85 ± 23.20	0.60
Diastolic Blood Pressure (DBP, mmHg, mean ± SD)	79.35 ± 10.19	77.90 ± 9.05	0.46
Total Cholesterol (mg/dL, mean ± SD)	209.8 ± 64.13	205.60 ± 50.16	0.72
LDL Cholesterol (LDL-C, mg/dL, mean ± SD)	144.13 ± 20.62	143.27 ± 20.02	0.83
HDL Cholesterol (HDL-C, mg/dL, mean ± SD)	33.67 ± 4.21	34.46 ± 5.00	0.41
Triglycerides (TG, mg/dL, mean ± SD)	198.9 ± 64.99	181.50 ± 57.79	0.17
Aspartate Aminotransferase (AST, IU/L, mean ± SD)	37.22 ± 13.51	41.17 ± 16.69	0.21
Alanine Aminotransferase (ALT, IU/L, mean ± SD)	42.74 ± 15.04	47.48 ± 18.35	0.17
Alkaline Phosphatase (ALP, IU/L, mean ± SD)	251.57 ± 32.89	248.08 ± 27.18	0.57
Fasting Blood Sugar (FBS, mg/dL, mean ± SD)	105.22 ± 9.04	105.81 ± 9.08	0.75
Insulin (µU/mL, mean ± SD)	10.38 ± 3.09	10.65 ± 3.02	0.67
HOMA-IR (mean ± SD)	2.78 ± 0.99	2.84 ± 0.98	0.74
Steatosis Grade, n (%)			
Grade 1	13 (28.3%)	16 (33.3%)	0.80**
Grade 2	28 (60.9%)	26 (54.2%)	
Grade 3	5 (10.9%)	6 (12.5%)	

*p-value from independent t-test; **p-value from chi-square test

Systolic blood pressure (SBP); diastolic blood pressure (DBP); low-density lipoprotein cholesterol (LDL-C); high-density lipoprotein cholesterol (HDL-C); triglycerides (TG); alanine aminotransferase (ALT); aspartate aminotransferase (AST); alkaline phosphatase (ALP); fasting blood sugar (FBS); homeostatic model assessment–insulin resistance (HOMA-IR).lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; TG: triglycerides; AST: aspartate aminotransferase; ALT: alanine aminotransferase; FBS: fasting blood sugar; ALP: alkaline phosphatase; HOMA-IR: homeostatic model assessment–insulin resistance.

Table 2 shows that liver enzyme levels decreased significantly in the placebo group ($p < 0.001$). In contrast, the intervention group experienced a significant decline only in ALP. After controlling for age, sex, BMI, and baseline values using ANCOVA, no significant differences were observed between the two groups in post-intervention liver enzyme levels.

Table 2. Mean values of anthropometric parameters, glycemic indices, lipid profile, and liver enzymes before and after the study in both groups.

Variable	Cranberry Group (n=46) Before	Cranberry Group After	Within-Cranberry p-value*	Placebo Group (n=48) Before	Placebo Group After	Within-Placebo p-value*	Between-Group p-value**
Body Mass Index (BMI, kg/m²)	28.17 ± 4.99	28.22 ± 5.06	0.32	28.63 ± 4.15	28.42 ± 4.07	0.68	0.34
Systolic Blood Pressure (SBP, mmHg)	127.39 ± 24.61	126.85 ± 25.01	0.22	124.85 ± 23.20	124.79 ± 24.25	0.89	0.37
Diastolic Blood Pressure (DBP, mmHg)	79.35 ± 10.19	79.78 ± 10.21	0.25	77.90 ± 9.05	78.65 ± 9.32	0.07	0.62
Alanine Aminotransferase (ALT, IU/L)	42.74 ± 15.04	39.54 ± 16.95	0.18	47.48 ± 18.35	38.69 ± 14.20	<0.001	0.27

Aspartate Aminotransferase (AST, IU/L)	37.22 ± 13.51	32.98 ± 14.33	0.05	41.17 ± 16.69	31.98 ± 12.48	<0.001	0.27
Alkaline Phosphatase (ALP, IU/L)	251.57 ± 32.89	224.33 ± 54.12	0.01	248.08 ± 27.18	221.40 ± 47.19	<0.001	0.77
Total Cholesterol (mg/dL)	209.8 ± 64.13	189.02 ± 63.62	<0.001	205.60 ± 50.16	200.29 ± 52.14	0.002	<0.001
LDL Cholesterol (LDL-C, mg/dL)	144.13 ± 20.62	133.96 ± 20.71	<0.001	143.27 ± 20.02	135.17 ± 19.34	0.24	0.23
HDL Cholesterol (HDL-C, mg/dL)	33.67 ± 4.21	38.28 ± 4.84	<0.001	34.46 ± 5.00	38.0 ± 4.99	<0.001	0.09
Triglycerides (TG, mg/dL)	198.9 ± 64.99	190.54 ± 65.22	<0.001	181.50 ± 57.79	188.54 ± 66.80	<0.001	0.01
Fasting Blood Sugar (FBS, mg/dL)	105.22 ± 9.04	98.65 ± 8.70	0.001	105.81 ± 9.08	100.48 ± 7.47	<0.001	0.28
Insulin (µU/mL)	10.38 ± 3.09	5.62 ± 2.04	<0.001	10.65 ± 3.02	10.06 ± 2.94	<0.001	<0.001
HOMA-IR	2.78 ± 0.99	1.39 ± 0.62	<0.001	2.84 ± 0.98	2.51 ± 0.85	<0.001	<0.001
Liver Steatosis Grade, n (%)							
No steatosis	0 (0%)	14 (30.4%)	0.04# (overall)	0 (0%)	0 (0%)	<0.001# (overall)	0.001#
Grade 1	13 (28.3%)	18 (39.1%)		16 (33.3%)	24 (50%)		
Grade 2	28 (60.9%)	13 (28.3%)		26 (54.2%)	20 (41.7%)		
Grade 3	5 (10.9%)	1 (2.2%)		6 (12.5%)	4 (8.3%)		

*Within-group P-values were calculated using paired t-tests;
**between-group comparisons were performed using ANCOVA, adjusted for sex, age, baseline values and BMI;
#chi-square test.

LDL-C, low-density lipoprotein cholesterol;SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides; AST, aspartate aminotransferase; ALT, alanine aminotransferase; FBS, fasting blood sugar; ALP, alkaline phosphatase; HOMA-IR, homeostatic model assessment–insulin resistance. After the intervention, the cranberry group showed significantly lower total triglyceride ($p = 0.01$) and cholesterol ($p < 0.001$) levels compared with the placebo group, after controlling for age, baseline values, sex, and BMI (**Table 2).**

Both groups exhibited reductions in glycemic measures over time; however, ANCOVA indicated that post-intervention insulin and HOMA-IR levels were notably lower in the cranberry group than in the control group. **Figure 2** illustrates the changes in hepatic steatosis. A greater proportion of participants in the cranberry group experienced improvement in steatosis compared with the placebo group ($P < 0.01$). Conversely, 8.7% of individuals in the cranberry group showed a one-grade increase in steatosis, while no increases occurred in the control group; this difference did not reach statistical significance ($p = 0.06$).

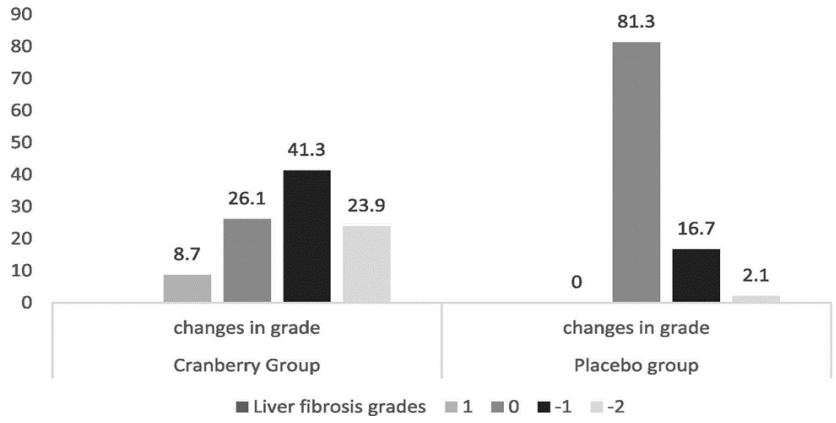

Figure 2. Changes in hepatic steatosis grades in the two groups.

This randomized controlled trial evaluated the effects of cranberry supplementation on cardiometabolic parameters and liver function in patients with NAFLD. The findings indicate that cranberry intake led to greater reductions in total cholesterol, triglycerides, insulin, and HOMA-IR compared with the placebo. These results regarding glycemic control are consistent with prior research in NAFLD populations [21]. Hormoznejad *et al*. reported that cranberry supplementation significantly improved insulin sensitivity and HOMA-IR levels in patients with NAFLD [21], and similar benefits have been observed in individuals with type 2 diabetes [22]. Importantly, improvements in glycemic outcomes in this study cannot be attributed to changes in body weight or caloric intake, suggesting that cranberry may enhance insulin sensitivity directly [23].

Both cranberry and placebo groups exhibited decreases in fasting blood sugar (FBS). Although the cranberry group showed a slightly larger reduction, this difference did not reach statistical significance, which aligns with previous studies [21]. Prior reports suggest that cranberry may reduce blood glucose by delaying gastric absorption or facilitating uptake into insulin-sensitive tissues [24]. Furthermore, vitamin E supplementation and calorie restriction, both applied in this study, have been shown to lower serum glucose [25, 26], likely explaining the decrease observed in the placebo group.

Regarding lipid profile, cranberry supplementation was associated with significant reductions in total cholesterol and triglycerides relative to the control group. This contrasts with some previous findings in NAFLD patients [21], possibly due to differences in study protocols. In the current study, participants received both vitamin E and calorie restriction, whereas in Hormoznejad *et al*.'s study, only dietary restriction was applied. Animal studies suggest that vitamin E and anthocyanins may work synergistically to reduce lipid levels, and antioxidants in fruits have been linked to improved lipid profiles in clinical trials [27]. Differences in dosage and duration of cranberry supplementation may also contribute to inconsistencies. Studies in type 2 diabetes populations have reported reductions in total cholesterol but not triglycerides [11], while meta-analyses on cranberry supplementation generally did not observe significant effects on lipid parameters [20]. The discrepancy between these results and our findings may be partly due to population differences, as our study specifically included NAFLD patients, unlike prior studies focusing on diabetes or metabolic syndrome.

The lipid-lowering effect observed may also relate to cranberry's polyphenols. Tannins, abundant in cranberry, can increase hepatic cholesterol uptake [28] and enhance intestinal excretion by binding bile acids [29, 30].

No significant between-group differences were found for liver enzymes. The only previous human study in NAFLD patients reported a reduction in ALT but not AST or ALP following cranberry supplementation [21]. Animal studies support a hepatoprotective effect of cranberry and anthocyanins [8, 9]. A likely reason for the differences is dosage: this study used 144 mg/day, whereas previous studies used higher doses, such as 288 mg/day [21].

Cranberry supplementation also improved hepatic steatosis. Animal studies corroborate these effects, showing decreased liver fat following cranberry or anthocyanin administration [8, 9, 23, 31, 32]. One potential mechanism is Pterostilbene, a compound in cranberry, which activates PPAR-α, promoting fatty acid β-oxidation, reducing hepatic triglycerides, and lowering circulating lipid levels [33]. In our study, four patients in the cranberry group experienced an increase in steatosis grade, which could be influenced by uncontrolled factors such as genetic predispositions, diet composition, or unreported alcohol consumption [34].

The study has limitations. We did not measure inflammatory or oxidative stress markers, and hepatic steatosis was assessed using ultrasonography rather than histology; while liver biopsy is the gold standard, ultrasound remains a practical, non-invasive method for NAFLD assessment [35]. Additionally, not all confounding factors, including genetic variants and detailed nutrient intake, were controlled, which could have affected the results.

Conclusion

In summary, this study suggests that cranberry supplementation may improve certain lipid parameters, reduce insulin resistance, and alleviate hepatic steatosis in patients with NAFLD. Nonetheless, due to the study's limitations, including sample size and the method used to evaluate liver fat, further long-term research with larger cohorts and more precise measures of hepatic steatosis is warranted to validate these preliminary findings.

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References

1. McCullough AJ. The clinical features, diagnosis and natural history of nonalcoholic fatty liver disease. Clin Liver Dis. 2004;8(3):521–533. doi: 10.1016/j.cld.2004.04.004
2. Younossi ZM, Koenig AB, Abdelatif D, Fazel Y, Henry L, Wymer M. Global epidemiology of nonalcoholic fatty liver disease—meta-analytic assessment of prevalence, incidence, and outcomes. Hepatology. 2016;64(1):73–84. doi: 10.1002/hep.28431
3. Younossi Z, Anstee QM, Marietti M, Hardy T, Henry L, Eslam M, George J, Bugianesi E. Global burden of NAFLD and NASH: trends, predictions, risk factors and prevention. Nat Rev Gastroenterol Hepatol. 2018;15(1):11–20. doi: 10.1038/nrgastro.2017.109
4. Mitra S, De A, Chowdhury A. Epidemiology of non-alcoholic and alcoholic fatty liver diseases. Transl Gastroenterol Hepatol. 2020;5:16:1–17.
5. Beaton MD. Current treatment options for nonalcoholic fatty liver disease and nonalcoholic steatohepatitis. Can J Gastroenterol. 2012;26(6):353–357. doi: 10.1155/2012/725468
6. Xu Y, Guo W, Zhang C, Chen F, Tan HY, Li S, et al. Herbal medicine in the treatment of non-alcoholic fatty liver diseases-efficacy, action mechanism, and clinical application. Front Pharmacol. 2020;11:1–19.
7. Narwojsz A, Tańska M, Mazur B, Borowska EJ. Fruit physical features, phenolic compounds profile and inhibition activities of cranberry cultivars (Vaccinium macrocarpon) compared to wild-grown cranberry (Vaccinium oxycoccus) Plant Foods Hum Nutr. 2019;74(3):300–306. doi: 10.1007/s11130-019-00737-7
8. Faheem SA, Saeed NM, El-Naga RN, Ayoub IM, Azab SS. Hepatoprotective effect of cranberry Nutraceutical extract in non-alcoholic fatty liver model in rats: impact on insulin resistance and Nrf-2 expression. Front Pharmacol. 2020;11:1–16.
9. Valenti L, Riso P, Mazzocchi A, Porrini M, Fargion S, Agostoni C. Dietary anthocyanins as nutritional therapy for nonalcoholic fatty liver disease. Oxid Med Cell Longev. 2013;2013:1–8.
10. Eftekhari M, Alaei M, Khosropanah S, Rajaeifard A, Akbarzadeh M. Effects of cranberry supplement on metabolic syndrome. 2014;22:963–73.
11. Lee IT, Chan YC, Lin CW, Lee WJ, Sheu WH. Effect of cranberry extracts on lipid profiles in subjects with type 2 diabetes. Diabet Med. 2008;25(12):1473–7.
12. Chambers BK. Can cranberry supplementation reduce risks for diabetes? 2002.
13. Basu A, Betts NM, Ortiz J, Simmons B, Wu M, Lyons TJ. Low-energy cranberry juice decreases lipid oxidation and increases plasma antioxidant capacity in women with metabolic syndrome. Nutr Res. 2011;31(3):190–196. doi: 10.1016/j.nutres.2011.02.003
14. Dohadwala MM, Holbrook M, Hamburg NM, Shenouda SM, Chung WB, Titas M, Kluge MA, Wang N, Palmisano J, Milbury PE. Effects of cranberry juice consumption on vascular function in patients with coronary artery disease. Am J Clin Nutr. 2011;93(5):934–940. doi: 10.3945/ajcn.110.004242
15. Novotny JA, Baer DJ, Khoo C, Gebauer SK, Charron CS. Cranberry juice consumption lowers markers of cardiometabolic risk, including blood pressure and circulating C-reactive protein, triglyceride, and glucose concentrations in adults. J Nutr. 2015;145(6):1185–1193. doi: 10.3945/jn.114.203190
16. Shidfar F, Heydari I, Hajimiresmaiel SJ, Hosseini S, Shidfar S, Amiri F. The effects of cranberry juice on serum glucose, apoB, apoA-I, Lp(a), and Paraoxonase-1 activity in type 2 diabetic male patients. J Res Med Sci. 2012;17(4):355–360.
17. 17.Flammer AJ, Martin EA, Gössl M, Widmer RJ, Lennon RJ, Sexton JA, Loeffler D, Khosla S, Lerman LO, Lerman A. Polyphenol-rich cranberry juice has a neutral effect on endothelial function but decreases the fraction of osteocalcin-expressing endothelial progenitor cells. Eur J Nutr. 2013;52(1):289–296. doi: 10.1007/s00394-012-0334-4
18. Ruel G, Couillard C. Evidences of the cardioprotective potential of fruits: the case of cranberries. Mol Nutr Food Res. 2007;51(6):692–701. doi: 10.1002/mnfr.200600286
19. Zare Javid A, Maghsoumi-Norouzabad L, Ashrafzadeh E, Yousefimanesh HA, Zakerkish M,

Ahmadi Angali K, Ravanbakhsh M, Babaei H. Impact of cranberry juice enriched with omega-3 fatty acids adjunct with nonsurgical periodontal treatment on metabolic control and periodontal status in type 2 patients with diabetes with periodontal disease. J Am Coll Nutr. 2018;37(1):71–79. doi: 10.1080/07315724.2017.1357509

20. Pourmasoumi M, Hadi A, Najafgholizadeh A, Joukar F, Mansour-Ghanaei F. The effects of cranberry on cardiovascular metabolic risk factors: a systematic review and meta-analysis. Clin Nutr. 2020;39(3):774–788. doi: 10.1016/j.clnu.2019.04.003
21. Hormoznejad R, Mohammad Shahi M, Rahim F, Helli B, Alavinejad P, Sharhani A. Combined cranberry supplementation and weight loss diet in non-alcoholic fatty liver disease: a double-blind placebo-controlled randomized clinical trial. Int J Food Sci Nutr. 2020;71(8):991–1000. doi: 10.1080/09637486.2020.1746957
22. Paquette M, Larqué ASM, Weisnagel S, Desjardins Y, Marois J, Pilon G, Dudonné S, Marette A, Jacques H. Strawberry and cranberry polyphenols improve insulin sensitivity in insulin-resistant, non-diabetic adults: a parallel, double-blind, controlled and randomised clinical trial. Br J Nutr. 2017;117(4):519–531. doi: 10.1017/S0007114517000393
23. Anhê FF, Roy D, Pilon G, Dudonné S, Matamoros S, Varin TV, Garofalo C, Moine Q, Desjardins Y, Levy E, et al. A polyphenol-rich cranberry extract protects from diet-induced obesity, insulin resistance and intestinal inflammation in association with increased Akkermansia spp. population in the gut microbiota of mice. Gut. 2015;64(6):872–883. doi: 10.1136/gutjnl-2014-307142
24. Wilson T, Meyers SL, Singh AP, Limburg PJ, Vorsa N. Favorable glycemic response of type 2 diabetics to low-calorie cranberry juice. J Food Sci. 2008;73(9):H241–H245. doi: 10.1111/j.1750-3841.2008.00964.x
25. Manning PJ, Sutherland WH, Walker RJ, Williams SM, De Jong SA, Ryalls AR, Berry EA. Effect of high-dose vitamin E on insulin resistance and associated parameters in overweight subjects. Diabetes Care. 2004;27(9):2166–2171. doi: 10.2337/diacare.27.9.2166
26. Atkinson RL, Kaiser DL. Effects of calorie restriction and weight loss on glucose and insulin levels in obese humans. J Am Coll Nutr. 1985;4(4):411–419. doi: 10.1080/07315724.1985.10720084
27. Esmaillzadeh A, Tahbaz F, Gaieni I, Alavi-Majd H, Azadbakht L. Concentrated pomegranate juice improves lipid profiles in diabetic patients with hyperlipidemia. J Med Food. 2004;7(3):305–308. doi: 10.1089/jmf.2004.7.305
28. Chu YF, Liu RH. Cranberries inhibit LDL oxidation and induce LDL receptor expression in hepatocytes. Life Sci. 2005;77(15):1892–1901. doi: 10.1016/j.lfs.2005.04.002
29. Kahlon TS, Smith GE. In vitro binding of bile acids by blueberries (Vaccinium spp.), plums (Prunus spp.), prunes (Prunus spp.), strawberries (Fragaria X ananassa), cherries (Malpighia punicifolia), cranberries (Vaccinium macrocarpon) and apples (Malus sylvestris) Food Chem. 2007;100(3):1182–1187. doi: 10.1016/j.foodchem.2005.10.066
30. Tebib K, Besançon P, Rouanet JM. Dietary grape seed tannins affect lipoproteins, lipoprotein lipases and tissue lipids in rats fed hypercholesterolemic diets. J Nutr. 1994;124(12):2451–2457. doi: 10.1093/jn/124.12.2451
31. Anhê FF, Nachbar RT, Varin TV, Vilela V, Dudonné S, Pilon G, Fournier M, Lecours M-A, Desjardins Y, Roy D. A polyphenol-rich cranberry extract reverses insulin resistance and hepatic steatosis independently of body weight loss. Mol Metab. 2017;6(12):1563–1573. doi: 10.1016/j.molmet.2017.10.003
32. Peixoto TC, Moura EG, de Oliveira E, Soares PN, Guarda DS, Bernardino DN, Ai XX, da ST Rodrigues V, de Souza GR, da Silva AJR. Cranberry (Vaccinium macrocarpon) extract treatment improves triglyceridemia, liver cholesterol, liver steatosis, oxidative damage and corticosteronemia in rats rendered obese by high fat diet. Eur J Nutr. 2018;57(5):1829–1844. doi: 10.1007/s00394-017-1467-2
33. Sun Q, Yue Y, Shen P, Yang JJ, Park Y. Cranberry product decreases fat accumulation in Caenorhabditis elegans. J Med Food. 2016;19(4):427–433. doi: 10.1089/jmf.2015.0133
34. Kechagias S, Nasr P, Blomdahl J, Ekstedt M. Established and emerging factors affecting the progression of nonalcoholic fatty liver disease. Metabolism. 2020;111:154183. doi: 10.1016/j.metabol.2020.154183

35. Masuzaki R, Tateishi R, Yoshida H, Goto E, Sato T, Ohki T, Goto T, Yoshida H, Kanai F, Sugioka Y, et al. Comparison of liver biopsy and transient elastography based on clinical relevance. Can J Gastroenterol. 2008;22(9):753–757. doi: 10.1155/2008/306726