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EFFECT OF CHYAWANPRASH AND VITAMIN C ON GLUCOSE TOLERANCE AND LIPOPROTEIN PROFILE†

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Abstract : Chyawanprash is an ancient Indian dietary supplement containing vitamin C (34 mg/100 g) derived from amla *(Emblica officinalis).* In addition, Chyawanprash also contains several other herbal products. The present study was designed to compare the effects of vitamin C with those of Chyawanprash. Ten normal healthy adult male volunteers (age 20–32 years) participated in the 16-week study. They were placed randomly in either the Chyawanprash group (n = 5) or vitamin C group (n = 5). Those in the former received 15 g/d of Chyawanprash while those in the latter received 500 mg/d vitamin C during the first 8 weeks of the study. For the next 8 weeks, no supplement was given. For each individual, an oral glucose tolerance test was performed, and lipoprotein profile in peripheral serum samples was determined at 0 weeks, 4 weeks, 8 weeks, 12 weeks and 16 weeks.

In the Chyawanprash group, the 8 weeks Vs 0 weeks value (mean ± S.D.) respectively for various indices which were significantly different were fasting plasma glucose (100.2 ± 5.58 mg/dl vs 116.2 ± 11.6 mg/dl), area under 2-h plasma glucose curve (245.9 ± 15.13 $mg.dl^{-1}.h$ vs 280.8 ± 37.09 $mg.dl^{-1}.h$), HDL cholesterol (53.2 ± 4.56 mg/dl vs 42.7 ± 7.17 mg/dl), LDL cholesterol (82.4 ± 8.80 mg/dl vs 98.26 ± 12.07 mg/dl), LDL/HDL ratio (1.56 ± 0.28 vs 2.38 ± 0.63). In the Vitamin C group, only the LDL/HDL ratio was significantly lower at 8 weeks than at 0 weeks (1.99 ± 0.44 vs 2.29 ± 0.43). All the variables that changed significantly were no longer significantly different from the 0 weeks value at 16 weeks. Chyawanprash reduces postprandial glycemia in the oral glucose tolerance test and reduces blood cholesterol level to a significantly greater extent than vitamin C.

Key words : Chyawanprash, vitamin C, ascorbic acid, glucose tolerance, lipoprotein, cholesterol

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INTRODUCTION

Chyawanprash is an ancient Indian Ayurvedic preparation, which has been claimed to have health promoting effects and has been advocated for degenerative diseases, heart disease and diabetes mellitus (1). A few studies are available on the anabolic effects of Chyawanprash (2–4). However, to our knowledge, there is no information about the effects of Chyawanprash on carbohydrate and lipid metabolism.

A major constituent of Chyawanprash is amla (*Emblica officinalis*) (about 7 g/100 g), which is a rich natural source of vitamin C. Extensive literature is available regarding the functions of vitamin C as an antioxidant, its protective role in degenerative diseases like coronary artery disease and in aging and its role in human metabolism including that in lipid and glucose metabolism. Also vitamin C is quite commonly consumed as a dietary supplement by healthy persons as is Chyawanprash (5–14).

With this background, the present study has examined the effects of ingestion of 15 g per day of Chyawanprash on the glucose metabolism and lipid profile in normal healthy volunteers and how this effect, if present, compares with that of 500 mg/d of vitamin C.

METHODS

Subjects

The study was conducted on 10 healthy young male volunteers. The volunteers were divided randomly into two groups of five volunteers each. The characteristics of the volunteers are given in Table I. The two groups were well matched as seen in the table. Subjects were enlisted for the study after they had given their informed written consent. The study was also approved by the Ethics Committee of All India Institute of Medical Sciences, New Delhi.

TABLE I: Age and physical characteristics of volunteers

Group	*Age (y)*	*Height (m)*	*Weight (kg)*	*BMI (kg/m^2)*
I	22.6±4.5	1.66±0.02	57.0±3.9	20.52±1.21
(n = 5)	(19–28)	(1.64–1.70)	(51–61)	(18.50–21.51)
II	28.6±2.07	1.69±0.03	61.4±7.6	21.28±1.76
(n = 5)	(27–32)	(1.65–1.75)	(51–72)	(18.73–23.51)

(All values are mean ± standard deviation. Values in parentheses are ranges).

Experimental design and procedures

Group I received 15 g per day Chyawanprash (Dabur, India) while group II received 500 mg/day vitamin C (tablet Celin, Glaxo, India) as dietary supplement for the first 8 wk of the study. During the next 8 wk, neither group received any supplement. The subjects were followed up every 4 wk. Blood samples were drawn before the start of the study (0 wk), at 4 wk, 8 wk, 12 wk and 16 wk for the estimation of fasting plasma glucose, glucose tolerance, serum lipid profile and plasma vitamin C levels. In addition to these principal outcome measures, body weight was recorded at 0 wk, 8 wk and 16 wk; and liver function tests and estimation of blood urea were done at the beginning and at the end of the study.

Oral glucose tolerance test was performed using the standard dose of 75 g glucose dissolved in 300 ml of water given in the morning after an overnight fast. Besides a fasting venous blood sample, blood samples were also collected 0.5 h, 1.0 h, 1.5 h and 2 h after ingestion of glucose. Plasma glucose levels were measured by glucose oxidase method (15) using commercial kits (Ranbaxy, India).

Serum cholesterol and its fractions and serum triacylglycerol were determined colorimetrically by enzymatic method (16) using commercial kits (Randox, UK).

Plasma vitamin C was also measured colorimetrically by tricarboxylic acid method (17).

Statistical analysis

The values at 4 wk, 8 wk, 12 wk and 16 wk were compared with '0' wk values of the same group using Wilcoxon Signed Rank test. The difference was considered significant if the P value was less than 0.05.

For comparing the changes in the two groups, first the '0' wk values of the two groups were compared using Wilcoxon Rank Sum test. After verifying that '0' wk values were not significantly different, the percentage changes at 4 wk, 8 wk, 12 wk and 16 wk were compared between the groups using Wilcoxon Rank Sum test. The groups were considered significantly different if P value was less than 0.05.

RESULTS

None of the subjects had any major complaints during the study. There was no significant change in the body weight during the study. The results of liver function tests and kidney function tests were found to be within normal limits both at the beginning and at the end of the study. There was also no significant change in the plasma vitamin C levels of the subjects in either group (Table II).

TABLE II: Plasma vitamin C levels in the two groups

Group	*Plasma vitamin C (mg/dl)*				
	0 wk	*4 wk*	*8 wk*	*12 wk*	*16 wk*
I (Chyawanprash)	0.37±0.09	0.34±0.13	0.36±0.11	0.34±0.09	0.30±0.14
II (Vitamin C)	0.43±0.22	0.41±0.16	0.41±0.25	0.39±0.24	0.43±0.24

(All values are mean ± SD)

Glucose tolerance

The effects of Chyawanprash on fasting plasma glucose and postprandial glucose levels during the glucose tolerance test have been tabulated in Table III. At 8^{th} wk, there was a significant reduction in the fasting plasma glucose level, 0.5 h glucose level, 1 h glucose level and area under 2-h plasma glucose curve (AUC) when compared to '0' wk value. After discontinuation of Chyawanprash at 8^{th} wk, the follow-up showed that the values returned close to baseline (0 wk) values by 16^{th} wk.

The effects of vitamin C on glucose tolerance have been tabulated in Table IV. The supplementation with vitamin C for 8 wk did not lead to any significant change in glucose tolerance at 4 or 8 wk, but there was a trend towards improvement in glucose tolerance. The values returned to baseline (0 wk) levels by 16^{th} wk.

The percentage change in the indicators of glucose tolerance at 8^{th} wk in Chyawanprash group have been compared with the corresponding changes in the vitamin C group in Fig 1. As seen in the figure, the percentage change in the plasma glucose values at 0.5 h and 1 h and the area under the 2-h plasma glucose curve (AUC) are significantly greater in the Chyawanprash group than in the vitamin C group.

TABLE III: Plasma glucose levels in Chyawanprash group.

No. of weeks	*Plasma glucose (mg/dl)*					*AUC* ($mg.dL^{-1}.h$)
	Fasting	*0.5 h*	*1 h*	*1.5 h*	*2 h*	
0	116.2±11.6	164±10.12	153±28.68	127±26.78	119±29.03	280.8±37.09
4	103.4±7.92	142±19.78	130.4±16.1	118.2±5.8	111.4±8.56	249±18.39
8	100.2±5.58*	138.2±8.1*	125.9±9.2*	123.4±11.9	110.4±9.76	245.9±15.13*
12	99.4±15.61	144.2±18.68	127.8±10.32	123.6±16.31	111.4±16.68	250.5±20.50
16	115±14.31	148.8±22.78	132.8±13.6	122.6±11.19	119.6±6.54	260.75±22.6

(All values are mean ± SD; *P<0 .05 compared to baseline value).

TABLE : IV Effect of Vitamin C on glucose tolerance.

No. of weeks	*Plasma glucose (mg/dl)*					*AUC* ($mg.dL^{-1}.h$)
	Fasting	*0.5 h*	*1 h*	*1.5 h*	*2 h*	
0	99.4±19.5	112.2±28.11	112.2±17.92	100.8±9.09	95.2±7.46	211.2±31.03
4	97.6±13.22	114.6±22.7	112.6±15.74	103.8±12.49	97.4±10.89	214.25±30.7
8	92±4.3	112±19.74	109.2±9.62	100.4±10.11	95.4±6.46	207.65±17.6
12	94.2±4.08	114.8±24.93	112.2±14.68	102.6±8.79	99±4.84	213.1±25.62
16	89.8±5.21	115±21.05	116.4±15.96	104.4±11.41	99.8±2.48	215.3±22.02

(All values are mean ± SD)

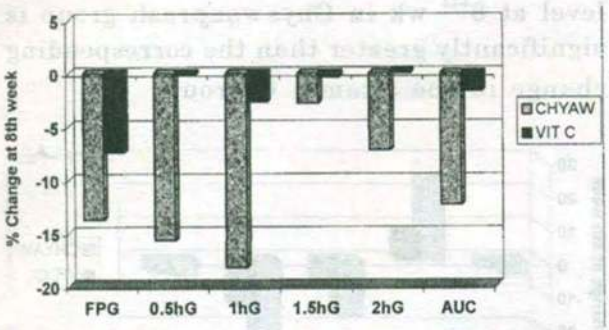

Fig. 1 : Comparison of the effects of Chyawanprash and vitamin C on observations made during the oral glucose tolerance test (OGTT) after 8 weeks of supplementation. FPG, fasting plasma glucose; 0.5 h G, 1 h G, 1.5 h G and 2 h G, plasma glucose 0.5 h, 1h, 1.5 h and 2 h respectively after ingestion of glucose during OGTT; AUC, area under the 2-h plasma glucose curve; chyaw, Chyawanprash; vit C, vitamin C.

Serum lipid profile

The effects of Chyawanprash on serum lipid profile have been shown in Table V.

As shown in Table V, total cholesterol level decreased gradually till 8th wk but the decrease was not statistically significant. The values returned closer to the baseline (0-wk) values by 16th wk. In case of HDL cholesterol levels, there was a significant increase in the levels at 4th wk and 8th wk. But the value was not statistically significantly different from the '0' wk value at 12th wk and returned close to the baseline (0 wk) level by 16th wk. The

TABLE V : Effect of Chyawanprash on serum lipid profile.

No. of weeks	*Lipid fraction (mg/dl)*				
	Total cholesterol	*HDL cholesterol*	*LDL cholesterol*	*LDL/HDL*	*Triacylglycerol (mg/dl)*
0	174.6±10.4	42.7±7.17	98.26±12.07	2.38±0.63	168.3±13.97
4	168±9.59	52.5±6.54*	82.1±15.23	1.60±0.46*	167±35.16
8	167.8±5.16	53.2±4.56*	82.4±8.80*	1.56±0.28*	161±10.07
12	170.6±7.02	46.9±6.82	90.78±9.15*	1.98±0.46	164.6±17.22
16	170±5.70	42.7±9.71	93.06±10.86	2.31±0.77	171.2±20.64

(All values are mean ± SD; *P<0 .05 compared to baseline value).

TABLE VI : Effect of vitamin C on serum lipid profile.

No. of weeks	*Lipid fraction (mg/dl)*				
	Total cholesterol	*HDL cholesterol*	*LDL cholesterol*	*LDL/HDL*	*Triacylglycerol (mg/dl)*
0	190±14.81	47.4±7.3	106.24±10	2.29±0.43	181.8±18.79
4	189±22	48.4±8.23	105.4±16.52	2.23±0.50	176±23
8	186±19.64	51.3±8.36	99.7±16.81	1.99±0.44*	175±15.79
12	191.6±13.93	50.6±5.54	104.96±11.6	2.10±0.33*	180.2±16.84
16	195.8±16.72	47.2±6.87	111±12.81	2.40±0.50	187.6±15.17

(All values are mean ± SD; *P<0 .05 compared to baseline value).

LDL cholesterol level was significantly lower than the '0' wk values by 8^{th} wk. This decrease was maintained even at 12 wk. But the value returned close to the baseline (0 wk) level by 16^{th} wk. The ratio of LDL cholesterol to HDL cholesterol decreased significantly by 4^{th} wk and continued to be significantly lower than the '0' wk value at 8^{th} wk. But as in the case of other variables, the ratio returned to the baseline (0 wk) value by 16^{th} wk. The total triacylglycerol level decreased marginally by 8^{th} wk but the decrease was not statistically significant.

The effects of vitamin C supplementation on serum lipid profile have been shown in Table VI. As seen in the Table, there was a marginal progressive decrease in the values of total cholesterol, LDL cholesterol and total triacylglycerol at 4^{th} and 8^{th} wk but it was not statistically significant. The values returned very close to the baseline (0 wk) values by 16^{th} wk. The HDL cholesterol levels increased marginally but not significantly till the 8^{th} wk and returned very close to the baseline (0-wk) values by 16^{th} wk. But as seen in Table VI, the LDL cholesterol to HDL cholesterol ratio was significantly lower at 8^{th} wk than at '0' wk. This decrease was maintained till 12^{th} wk. But by 16^{th} wk, the value returned to the baseline (0 wk) value.

The percentage changes in the serum lipid profile at 8^{th} wk in Chyawanprash group have been compared with the corresponding changes in the vitamin C group in Fig 2. As seen in the figure, the trend of changes is similar in the two groups but the changes are somewhat more in Chyawanprash group. But only the decrease in LDL cholesterol level at 8^{th} wk in Chyawanprash group is significantly greater than the corresponding change in the vitamin C group.

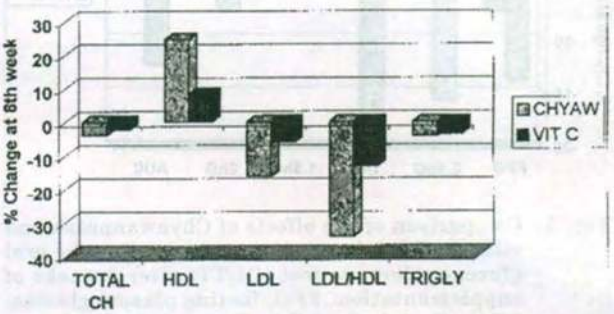

Fig. 2. Comparison of the effects of Chyawanprash and vitamin C on serum lipid profile after 8 weeks of supplementation. Total CH, total cholesterol; HDL, high density lipoprotein cholesterol; LDL, low density lipoprotein cholesterol; TRIGLY, triacylglycerols; chyaw, Chyawanprash; vit C, vitamin C

DISCUSSION

Supplementation with Chyawanprash for 8 wk resulted in a significant decrease in the fasting plasma glucose levels. Also, in the oral glucose tolerance test, Chyawanprash led to a significant improvement in glucose tolerance at 8th wk as compared to baseline (0 wk). The effect is unlikely to be due to vitamin C because the dose of Chyawanprash given in the study supplies only about 5 mg of vitamin C per day while even 500 mg of vitamin C per day has not given a comparable improvement in glucose tolerance. As Chyawanprash is a complex mixture of many ingredients, a combined effect, which may be additive or even multiplicative due to mutual interactions, would be the most probable and logical explanation of this effect rather than any one active principle. The aminoglycans and the flavonoid glycosides, the active principles of *Asparagus racemosus* have a significant

hypoglycemic activity. The resins and fibre content of many of the herbs could be responsible for the slower absorption of glucose, which in turn, reduces the glycemic response (18). Diets with low glycemic index also improve long term glucose tolerance (19). The dehydroascorbic acid-tannoid conjugates and flavonoids which are strong anti-oxidants, may also be partly responsible for the effect. The amino acids present could also be partly responsible by inducing insulinaemic response (20). All the factors put together could be having synergistic effect, which might be the cause of better glucose tolerance seen with Chyawanprash supplementation.

It is commonly said that Chyawanprash may be undesirable for persons having diabetes mellitus because of its high carbohydrate (sucrose) content. But the daily dose of Chyawanprash used in this study (15 g/d) has only 12 g sucrose. 12 g of sucrose is a very small quantity at any meal. Further, since this quantity of sugar in Chyawanprash is associated with fat, fibre and protein, its glycemic response will be markedly attenuated (21). In fact, it has been observed in a preliminary study with three NIDDM patients that their glucose tolerance improved with daily ingestion of 15 g of Chyawanprash for 8 wk (Manjunatha S, unpublished data).

Supplementation with Chyawanprash has shown favourable effects on serum lipid profile as well. By the 4^{th} wk itself, there was a significant increase in HDL cholesterol and decrease in LDL cholesterol as compared to baseline values. These effects became more pronounced by the 8^{th} wk and persisted even 4 wk after discontinuing Chyawanprash. The beneficial effect of Chyawanprash on lipid profile is most likely to be due to the combined effect of several chemicals. The phytosterols, which are present in the Chyawanprash, compete with cholesterol for absorption at intestinal mucosa and are known to decrease cholesterol absorption (22). The non-starch polysaccharides like galactomannan could further decrease the cholesterol absorption. The saponins, steroidal or triterpenoid amphiphilic glycosides are not absorbed from the intestine but precipitate cholesterol and interfere with micelle formation by enhancing the binding of bile acids to fibre, which in turn decreases dietary cholesterol absorption (23). Reduction in cholesterol absorption and increase in fecal bile salt excretion due to binding by dietary fibre have a synergistic effect. Increased fecal bile salt excretion reduces their enterohepatic circulation, which in turn increases the need for *de novo* synthesis of bile salts. Synthesis of bile salts uses up cholesterol, thereby reducing its level in the blood (24). The tannins present are known to reduce the activity of digestive enzymes which could be responsible for both decreased digestion and absorption of lipids as well as glucose (23). Considering the fact that all these chemicals are present in Chyawanprash and the possibility of synergistic interaction among themselves, it is not really surprising that Chyawanprash has a beneficial effect on lipid profile.

It is commonly said that the base of Chyawanprash is *ghee* (clarified butter), which is an animal fat, about 62% of which is saturated and therefore Chyawanprash may raise blood cholesterol. First, the remaining 38% of monounsaturated and polyunsaturated fats in ghee would possibly counteract the effect of saturated fat. Secondly, and more importantly,

Chyawanprash contains 5% fat. Therefore 15 g/d of Chyawanprash would provide only 0.75 g/d of fat. This quantity of fat in the form of ghee in a mixed diet is unlikely to have any appreciable effect on blood lipid profile.

On the other hand, supplementation with vitamin C did not result in any significant change in glucose tolerance either at 4th wk or 8th wk although there was a trend towards improved glucose tolerance. A significant reduction in blood glucose values following i.v. injection of 65 mg/kg L-ascorbic acid in rats was shown by Cheng et al (25). In human volunteers, Paolisso et al (26) demonstrated a reduction in fasting plasma glucose levels following a vitamin C supplement of 500 mg twice daily. These findings have been supported by demographic studies (27). The discrepancy between these studies and the present study may be due to the fact that the amount of vitamin C in this study was 500 mg/day and duration was 8 wk, both of which are less compared to the above study by Paolisso et al (26) who had used a higher dose for a longer duration (1000 mg/d for 6 months).

Vitamin C supplementation had a favourable effect on serum lipid profile. Although there was a trend towards gradual decrease in LDL-cholesterol and increase in HDL-cholesterol levels till 8th wk it was statistically not significant. However, the LDL-cholesterol/HDL cholesterol ratio was significantly less at wk 8 compared to the baseline (0 wk) values. The change persisted till the 12th wk. In a previous study, Cerna et al (9) had shown similar results but in addition there was a significant decrease in LDL-cholesterol and increase in HDL-cholesterol. In another study, Jacques et al (10) had shown an increase in HDL-cholesterol levels. The more pronounced effects in these studies than in the present study could possibly be because Cerna et al (9) conducted the study on hyperlipidemic subjects where there is a greater scope for possible reduction and Jacques et al (10) used a higher dose (1 g/day) of vitamin C for a much longer time (8 months). In the present study, the subjects were healthy normolipidemic volunteers and the amount of vitamin C given was 500 mg/day for only 8 wk.

When the effects of Chyawanprash were compared to those of vitamin C it was found that only Chyawanprash improved the glucose tolerance and Chyawanprash was more effective than vitamin C in improving the blood lipid profile. Keeping in view the doses given vitamin C could have made only a minor contribution to the effects of Chyawanprash. It seems that the effects of Chyawanprash are due to the presence, and possible interaction, of many substances.

Further studies are required for identifying individual effects of the constituents of Chyawanprash separately and/or in combination. Also, in this study, only the effects on glucose and lipid metabolism have been studied. Studies are also required on the effect of Chyawanprash on antioxidant status, immunity and various degenerative diseases.

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