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AMELIORATIVE IMPACT OF CINNAMON (CINNAMONUM VERUM J. PRESL) ON THE BLOOD GLUCOSE, LIPID PROFILE AND MARKER ENZYMES IN CIRRHINUS MRIGALA

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ABSTRACT

The increasing rate of diabetes and other non communicable diseases is driven by a combination of factors such as rapid urbanization, rich lifestyles, unhealthy food and tobacco usage. The total number of people with diabetes is expected to rise from 171 million in 2000 to 366 million in 2030. An unidentified factor isolated from cinnamon has been termed as insulin potentiating factor (IPF). This insulin potentiating factor may be involved in the alleviation of the signs and symptoms of diabetes and other diseases related to insulin resistance. The aim of the present work is to study the effects of oral administration of cinnamon on the biochemical and enzyme profile of the fish. The experimental set up includes one control and three experimental tubs marked as 1g, 3g and 5g. Fishes in the control were fed with the basal diet whereas the experimental fishes were fed with the basal diet and cinnamon of concentrations 1, 3, 5g/ 100g of basal feed respectively. Serum blood glucose level, Total serum cholesterol, serum triglyceride, HDL, Low density lipoprotein SGOT and SGPT activity were estimated after 45 days of treatment. A decrease was observed in the blood glucose level, Total serum cholesterol, serum triglyceride, Low density lipoprotein SGOT and SGPT and an increase in the HDL level. Cinnamon is found to have a major role in insulin sensitivity, which improves insulin efficiency and decreases the levels which are needed for equivalent metabolic effect. More recently, scientific attention has also been paid to the insulin potentiating capabilities of cinnamon, which may prove beneficial for diabetic patients.

KEYWORDS: Diabetes mellitus, cinnamon, Serum blood glucose level, Total serum cholesterol, serum triglyceride, HDL, Low density lipoprotein, SGOT and SGPT.

INTRODUCTION

India has an estimated diabetic population of about 8.7% in the age group of 20 and 70 years. The increasing rate of diabetes and other non communicable diseases is driven by a combination of factors such as rapid urbanization, rich lifestyles, unhealthy food and tobacco usage.

In 2013, 65.1 million people have diabetes in India. The crude prevalence rate of diabetes is about 9% in the urban areas of India. Diabetes is affecting Indians at a much younger age. Genetic susceptibility for diabetes has been found in Asian population which interacts with modern environmental factors like high fat diet, low physical activity to cause the disease with heavy morbidity and mortality. Indians are metabolically obese with normal BMI, less muscle mass, high percent body fat, which make them more susceptible to this disease (Ramchandran *et al.*, 2012).

The prevalence of diabetes for all age groups worldwide was estimated to be 2.8% in 2000 and will be 4.4% in 2030. The total number of people with diabetes is expected to rise from 171 million in 2000 to 366 million in 2030 (Wild *et al.*, 2004).

Cinnamomum verum (*C. zeylanicum*), true cinnamon or ceylon cinnamon, is an evergreen tree in the Laurel family. This plant has been used in ayurvedic (Indian traditional medicine) and other medicinal traditions in South Asia and America (Linares *et al.*, 1994; Gonzalez, 1998; Aguilar, 2006). The parts of this important plant used medicinally are the outer bark, inner bark, leaves and essential oil (Stuart, 2006).

Cinnamon is widely believed to be high in anti-oxidants. Regular drinking of Cinnamon tea could be beneficial to oxidative stress related illness in humans. Cinnamon contains a natural chemical called cinnamaldehyde, which studies show increases the hormone progesterone and decreases testosterone production in women, helping to balance hormones. Cinnamon is associated with a number of health benefits. The volatile oil extracted from its bark is a trusted cure for a common colds and diarrhea. The extract is believed to be an antioxidant that also has antimicrobial properties, making the spice a preferred preservative. Along with its inherent properties that help fight inflammation, the flavor appeals to all age groups. Cinnamon was probably the first spice used by man (Maheshwari *et al*., 2013).

Interest in cinnamon as a potentially useful treatment for the type 2 diabetes mellitus began almost 20 years ago. An unidentified factor isolated from cinnamon has been termed as insulin potentiating factor (IPF). This insulin potentiating factor may be involved in the alleviation of the signs and symptoms of diabetes and other diseases related to insulin resistance (Khan *et al.*, 1990). The unidentified factor present in cinnamon as methyl hydroxychalcone polymer (MHCP) has been characterized and investigated for its ability to function as insulin mimetic in 3T3-L1 adipocytes (Jarvill-Taylor *et al.*,2001).

Demonstrated that intake of 1, 3 or 6g of cinnamon per day reduces serum glucose, triglyceride, LDL cholesterol and total cholesterol in people with type 2 diabetes and suggested that the inclusion of cinnamon in the diet of people with type 2 diabetes will reduce the risk factors associated with diabetes and cardiovascular diseases (Gullapalli *et al.*, 2013; Crawford, 2009; Davis and Yokoyama, 2011; Al-Jamal, 2009; Singh and Boolchandani, 2014; Kumar and Mukkadan, 2013). The objective of the present work is to study the effects of oral administration of cinnamon on the biochemical and enzyme profile of the fish.

MATERIALS AND METHODS

The experimental set up includes one control and three experimental tubs marked as 1g, 3g and 5g. Fishes in the control were fed with the basal diet whereas the experimental fishes were fed with the basal diet and cinnamon of concentrations 1, 3, 5g/ 100g of basal feed respectively. The experimental set up was maintained for 45 days. Fishes were purchased from the fishery unit near Aliyar dam, Pollachi, Coimbatore District, Tamilnadu. The fingerlings ranged from 10 to 12 cm and weighed about 10 – 12 g. They were transported to the lab in oxygenated polythene bags. Fishes were acclimatized in the lab for 10 days. The diet of Bhosale (2010) was followed which includes soybean, groundnut cake and corn flour in the ratio of 2:2:1. The tanks were maintained and kept clean in order to avoid contamination.

Serum blood glucose level was measured by enzymatic method (Trinder, 1969). Total serum cholesterol was done by enzymatic method (Richmond, 1973; Sidel *et al.*, 1983). The serum triglyceride was measured by enzymatic method (Fossati and Prencipe 1982). HDL was determined by Friedwald, (1972) and Low density lipoprotein by Uddin, (2011). SGOT activity was estimated by 2,4-DNPH method (Reitman and Frankel, 1957). SGPT activity was estimated by 2,4-DNPH method (Reitman and Frankel, 1957).

Statistical Analysis

Mean, Standard Deviation, one way ANOVA, two way ANOVA and DMRT was done for Bio-chemistry and Enzyme studies.

Table 1: Bio-Chemical parameters of the blood of *Cirrhinus mrigala* treated with various concentrations of cinnamon on the 30th day of experimentation.

SAMPLE	GLUCOSE (mg/dl)	TOTAL CHOLESTEROL (mg/dl)	LDL (mg/dl)	HDL (mg/dl)	TRIGLYCERIDES (mg/dl)
Control	61±0.7071**	160±1.1402**	86±1.2247**	39±2.3108**	175±1.2247**
T1 (1g)	56±0.7071**	154±1.5033**	75±1.5033**	49±1.7697**	150±1.1402**
T2 (3g)	44±1.1402**	149±1.1402**	66±1.1402**	54±1.4738**	145±1.1402**
T3 (5g)	40±0.7071**	145±1.1402**	62±1.1402**	56±1.9463**	135±1.6432**

Values are Mean ± standard error; **-significant at P<0.01.

Table 2: One way ANOVA for the Bio-chemical parameters of the blood of *Cirrhinus mrigala* treated with various concentrations of cinnamon on the 30th day of experimentation.

SAMPLE	Df	SS	MS	F	P	CV%
GLUCOSE	3	1463.750000	487.916667	209.11	0.0000**	3.0%
TOTAL CHOLESTEROL	3	643.3500000	214.4500000	46.87	0.0000**	1.4%
LDL	3	1703.750000	567.916667	63.99	0.0000**	4.1%
HDL	3	863.350000	287.783333	21.22	0.0000**	7.4%
TRIGLYCERIDES	3	4343.750000	1447.916667	202.03	0.0000**	1.8%

df - degrees of freedom; **SS** - sum of squares; **MS** - mean square; **F** - F - test; **P** - probability; **CV** – coefficient of variation; ** - significant at P < 0.01 level.

Table 3: DMRT for the Bio-chemical parameters of the blood of *Cirrhinus mrigala* treated with various concentrations of cinnamon on 30th day of experimentation.

TEST	CONTROL	T1 (1g)	T2 (3g)	T4 (5g)	MEAN
GLUCOSE	61.000[a]	56.000[b]	44.000[c]	40.000[d]	50.250
TOTAL CHOLESTEROL	160.000[a]	154.000[b]	149.000[c]	145.000[d]	152.150
LDL	86.000[a]	75.000[b]	66.000[c]	62.000[c]	72.250
HDL	39.000[c]	49.000[b]	54.000[ab]	56.000[a]	49.650
TRIGLYCERIDES	175.000[a]	150.000[b]	145.000[c]	135.000[d]	151.250

Mean followed by a common letter are not significantly different at the 5% level by DMRT.

Table 4: Bio-Chemical analysis of the blood of *Cirrhinus mrigala* treated with various concentrations of cinnamon on 45th day of experimentation.

SAMPLE	GLUCOSE (mg/dl)	TOTAL CHOLESTEROL (mg/dl)	LDL (mg/dl)	HDL (mg/dl)	TRIGLYCERIDES (mg/dl)
Control	68±0.7071**	170±1.3038**	90±1.6505**	45±0.3406**	175±1.2247**
T1 (1g)	50±0.7071**	162±0.7071**	80±0.5020**	50±0.6293**	160±1.0000**
T2 (3g)	48±0.7071**	158±1.4832**	72±1.3579**	55±1.0752**	155±0.7071**
T3 (5g)	42±1.1402**	150±1.1402**	62±1.7550**	58±0.7071**	150±1.0000**

Values are Mean ± standard error; **-significant at P<0.01.

Table 5: One way ANOVA for the Bio-chemical analysis of the blood of *Cirrhinus mrigala* treated with various concentrations of cinnamon on 45th day of experimentation.

SAMPLE	Df	SS	MS	F	P	CV%
GLUCOSE	3	1880.000000	626.666667	254.92	0.0000**	3.0%
TOTAL CHOLESTEROL	3	1040.000000	346.666667	59.01	0.0000**	1.5%
LDL	3	2120.000000	706.666667	89.68	0.0000**	3.7%
HDL	3	490.0000000	163.3333333	49.12	0.0000**	3.5%
TRIGLYCERIDES	3	1750.000000	583.3333333	222.22	0.0000**	1.0%

df - degrees of freedom; **SS** - sum of squares; **MS** - mean square; **F** - F - test; **P** - probability; **CV** – coefficient of variation; ** - significant at P < 0.01 level.

Table 6: DMRT for the Bio-chemical analysis of the blood of *Cirrhinus mrigala* treated with various concentrations of cinnamon on 45th day of experimentation.

TEST	CONTROL	T1 (1g)	T2 (3g)	T3 (5g)	MEAN
GLUCOSE	68.000[a]	50.000[b]	48.000[b]	42.000[c]	52.000
TOTAL CHOLESTEROL	170.000[a]	162.000[b]	158.000[c]	150.000[d]	160.000
LDL	90.000[a]	80.000[b]	72.000[c]	62.000[d]	76.000
HDL	45.000[d]	50.000[c]	55.000[b]	58.000[a]	52.000
TRIGLYCERIDES	175.000[a]	160.000[b]	155.000[c]	150.000[d]	160.000

Mean followed by a common letter are not significantly different at the 5% level by DMRT.

Table 7: Two way ANOVA for the Bio-chemical analysis of the blood of *Cirrhinus mrigala* Treated with various concentrations of cinnamon.

SAMPLE	Df	SS	MS	F	P	CV%
GLUCOSE	7	3374.375000	483.053571	197.77	0.0000**	3.1%
TOTAL CHOLESTEROL	7	2299.575000	328.510714	65.45	0.0000**	1.4%
LDL	7	3964.375000	566.339286	59.88	0.0000**	4.1%
HDL	7	1408.575000	201.225000	19.85	0.0000**	6.3%
TRIGLYCERIDES	7	6859.375000	979.910714	131.12	0.0000**	1.8%

df - degrees of freedom; **SS** - sum of squares; **MS** - mean square; **F** - F - test; **P** - probability; **CV** – coefficient of variation; ** - significant at P < 0.01 level.

Table 8: Estimation of enzymes of *Cirrhinus mrigala* treated with various concentrations of cinamon on 45th day of experimentation.

SAMPLE	ALANINE AMINO TRANSFERASE (U/L)	ASPARTATE AMINO TRANSFERASE (U/L)
Control	35±0.7071**	21±0.7071**
T1 (1g)	27±0.7071**	17±0.7071**
T2 (3g)	23±0.7071**	13±0.7071**
T3 (5g)	21±0.7071**	11±0.7071**

Values are Mean ± standard error; **-significant at P<0.01.

Table 9: One way ANOVA for the enzyme analysis of the blood of *Cirrhinus mrigala* treated with various concentrations of cinnamon on 45th day of experimentation.

SAMPLE	Df	SS	MS	F	P	CV%
ALT	3	575.0000000	191.6666667	76.67	0.0000**	6.0%
AST	3	295.0000000	98.3333333	63.78	0.0000**	8.0%

df - degrees of freedom; **SS** - sum of squares; **MS** - mean square; **F** - F - test; **P** - probability; **CV** – coefficient of variation; ** - significant at P < 0.01 level.

Table 10: DMRT for the enzyme analysis of the blood of *Cirrhinus mrigala* treated with various concentrations of cinnamon on 45th day of experimentation.

TEST	CONTROL	T1 (1g)	T2 (3g)	T3 (5g)	MEAN
ALT	35.000[a]	27.000[b]	23.000[c]	21.000[c]	26.500
AST	21.000[a]	17.000[b]	13.000[c]	11.000[d]	15.500

Means followed by a common letter are not significantly different at the 5% level by DMRT.

RESULTS AND DISCUSSION

Dietary supplements, as a whole, can potentially provide us with a rich source of relatively inexpensive, safe, and healthy adjuvants to medicinal therapy for a wide range of diseases. If such products are tested and proven to be useful, it would bring a great benefit to the population by reducing the total number of medicines required by the patient, and by supplementing vitamins and other nutrients that these patients might be lacking.

Glucose

The mean glucose value of the control on the 30th day is 61±0.70 (P<0.01). There is a significant decrease in all the experiment groups namely 56±0.70 (P<0.01), 44±1.1402 (P<0.01) and 40±0.70 (P<0.01) respectively. The mean glucose value of the control on the 45th day is 68±0.70 (P<0.01). There is a significant decrease in all the experiment 50±0.70 (P<0.01), 48±1.14 (P<0.01) and 42±0.70 (P<0.01) respectively. The one way ANOVA for the levels of glucose in the control and experimental groups are significant at 1% level. The mean comparison by DMRT is significant for all the groups at 5% level.

The study of Hossein, (2012) revealed that 1.5 g of cinnamon supplementation for 8 weeks improves fasting blood glucose levels and lipid profiles in type 2 diabetic patients. Another study reported that cinnamon consumption in doses of 1, 3, or 6 g daily for a period of 40 days led to a major reduction in fasting blood glucose, triglyceride, low-density lipoprotein (LDL), and total cholesterol levels (Khan *et al.*, 2013). Mang *et al.*, (2006) suggested that cinnamon extract seems to have a moderate effect in lowering serum fasting glucose concentrations in glycemically controlled diabetic mellitus patients. They concluded that, the consumption of cinnamon in diabetic patients with poor glycemic control is averagely effective on blood glucose levels.

Cinnamon extracts have also been shown to improve insulin receptor function by activating insulin receptor kinase and inhibiting insulin sensitivity (Mahpara *et al.*, 2004). Cinnamon produces a specific digestive enzyme from the pancreas which has the capability to slow down the rate of absorption of sugars from the food. This reduces the blood sugar spikes and similarly also reduces the corresponding insulin spikes in the blood stream.

Triglyceride

The mean Triglyceride value of the control is 175.00 (P<0.01). There is significant decrease in all the experimental groups 150.00 (P<0.01), 145.00 (P<0.05) and 135.00 (P<0.01) respectively. There is a significant decrease in all the experimental groups namely 1g, 3g and 5g of cinnamon treated fishes on the 45th day. The values are 160.00 (P<0.01), 155.00 (P<0.05) and 150.00 (P<0.01) respectively. The one way ANOVA for the levels of Triglycerides in the control and experimental is significant at 1% level. The mean comparison by DMRT is significant for all the groups at 5% level.

The results of a study indicated that the levels of serum triglycerides were significantly decreased by cinnamon powder and cinnamon aqueous extract Soheir *et al.*, 2010). A greater reduction was observed in the cinnamon supplemented group which brings out the potential benefits of cinnamon in lowering the triglyceride levels among the hyperlipidemic diabetics (Balasasirekha and Lakshmi, 2012).

In regards to the decrease in blood triglyceride concentration, studies have shown that polyphenols found in cinnamon increase glycogen synthesis and decrease glycogenolysis (Medagama, 2015), decrease the absorption of glucose by the small intestine and regulate Peroxisome proliferator-activated receptor alpha (PPAR-α) and gamma-mediated metabolism (Kim, 2006), findings which are corroborated by other research (Ranasinghe *et al.,* 2012).

High density lipid

The control value for High Density Lipid is 39.00 (P<0.01). Significant increase in High Density Lipid is observed in 1g (49.00 P<0.05), 3g (54.00 P<0.01) and 5g (56.00 P<0.01) of cinnamon treated fishes. The control value for High Density Lipid is 45.00 (P<0.01). Significant increase in High Density Lipid is observed in 1g (50.00 P<0.05), 3g (55.00 P<0.01) and 5g (58.00 P<0.01) of cinnamon treated fishes. The one way ANOVA for the levels of High Density Lipid in the control and experimental is significant at 1% level. The mean comparison by DMRT is significant for all the groups at 5% level.

Administration of cinnamon extract improved the lipid profile which is parallel to the findings of Saleh *et al.*,(2016) and the results of others in diabetic rats (Khan *et al.,* and Qin *et al.,* 2003, Al-Jamal and Rasheed, 2010, Longe *et al.,* 2015, Soliman *et al.,* 2013). Cinnamon bark powder has a strong lipolytic activity that prevents hypercholesterolemia and hypertriglyceridemia with a reduction of free fatty acid levels in type 2 diabetic subjects (Khan *et al.,* 2003). Maximum increase was seen in the cinnamon supplemented group followed by turmeric group. Results of the study revealed greater scope for increasing the HDL cholesterol levels by supplementing spices such as cinnamon and turmeric (Balasasirekha and Lakshmi, 2012).

Low density lipid

The mean Low Density Lipid value for the control is 86.00 (P<0.01). There is a significant decrease in all the experimental groups namely 1g, 3g, and 5g of cinnamon treated fishes. The values are 75.00 (P<0.01), 66.00 (P<0.05) and 62.00 (P<0.01) respectively. The mean Low Density Lipid value for the control is 90.00 (P<0.01). There is a significant decrease in all the experimental groups 80.00 (P<0.01), 72.00 (P<0.05) and 62.00 (P<0.01) respectively. The one way ANOVA for the levels of Low Density Lipid in the control and experimental is significant at 1% level. The mean comparison by DMRT is significant for all the groups at 5% level.

Lipoprotein fractions present in apo-B are considered to be responsible for deposition of cholesterol in atherosclerotic plaques. It clearly reflects that elevation in HDL-cholesterol level and decrease in LDL-cholesterol level would be a lucrative treatment and prevention of atherosclerosis. Atherogenic index (total cholesterol/HDL-cholesterol) is used to indicate the extent to which treatment is effective for its antihyperlipidaemic effect (Choi *et al.,* 1991; Balasasirekha and Lakshmi, 2012).

Total cholesterol

The total cholesterol values showed a significant decrease in all the treatments cinnamon treated fishes 154±1.50 (P<0.01), 149±1.14 (P<0.01), 145±1.14 P(<0.01) when compared to the control on 30th day 160±1.14 (P<0.01). The total cholesterol values showed a significant decrease in all the treatments 1g, 3g, and 5g cinnamon treated fishes 154±1.50 (P<0.01), 149±1.14 (P<0.01), 145±1.14 (P<0.01) when compared to the control on 45th day 160±1.14 (P<0.01). The one way ANOVA for the total cholesterol in the control and experimental groups are significant at 1% level and DMRT values are significant at 5% level.

The insulin potentiating property of cinnamon may be helping in reducing the cholesterol level. Those individuals who have high cholesterol levels may adopt regular eating of 1-3g cinnamon daily to lower their cholesterol levels (Khan *et al.,* 2003). Cinnamate found in cinnamon bark reduces the level of cholesterol in high fat diet fed rats by inhibiting the activity of hepatic 5hydroxy-3-methylglutaryl-coenzyme A reductase (Lee *et al.,* 2003).

The mechanism involved in cholesterol lowering activity of cinnamon may be due to the inhibition of lipid absorption (Goyal and Grewal, 2003) or augmented cholesterol and bile acids secretion in faeces (Agarwal and Chavan, 1988). The decrease in chylomicron absorption and possible increase in triglyceride uptake by adipocytes could explain our findings. The possible activation of proliferator-activated receptors by cinnamon could help explain the reduction in blood cholesterol (Konig *et al.,* 2007).

ENZYME PROFILE

Alanine amino Transferase

The values of Alanine amino transferase showed a significant decrease in all the treatments (27±0.70, 23±0.70, 21±0.70) when compared to the control on 45th day 35±0.70 (P<0.01).

Alanine amino transferase (ALT) is a chemical found principally in the liver and kidney. It was initially alluded to as serum glutamic pyruvic transaminase (SGPT). Ordinarily, a low dimension of ALT exists in the serum. ALT is expanded with liver harm and is utilized to screen liver illness. Proteins called enzymes help the liver break down other proteins so the body can absorb them more easily. ALT is one of these enzymes. It plays a crucial role in metabolism, the process that turns food into energy.

ALT is normally found inside liver cells. However, when the liver is damaged or inflamed, ALT can be released

into the bloodstream. This causes serum ALT levels to rise. Measuring the level of ALT in a person's blood can help doctors evaluate liver function or determine the underlying cause of a liver problem. The ALT test is often part of an initial screening for liver disease.

Aspartate amino transferase

The values of Aspartate amino transferase showed a significant decrease in all the treatments (17±0.70, 13±0.70, 11±0.70) when compared to the control on 45th day 21±0.70 (P<0.01).

The blood test for aspartate aminotransferase (AST) is typically used to recognize liver harm. AST is found in the most elevated fixations in the liver, muscles, heart, kidney, cerebrum and red platelets. A little measure of AST is ordinarily in the circulation system. Higher-than-typical measures of this catalyst in the blood might be an indication of a medical issue. Irregular dimensions can be related with liver damage.

AST levels increment when there is harm to the tissues and cells where the protein is found. AST levels can ascend when six hours after harm to tissue happens. The ordinary range for AST is higher from birth to age 3 contrasted with the typical reaches for more established kids and grown-ups.ALT is the most frequently utilized and specific test for hepatocellular necrosis and its level is increased in almost all liver diseases (Friedman *et al.*, 2003). In medicine, the presence of elevated values of ALT and AST is indicative of liver damage (Giboney, 2005). The activity of serum ALT and AST highly significantly decreased after oral administration of cinnamon aqueous extract (Soheir*et al.*, 2010).

CONCLUSION

Cinnamon is found to have a major role in insulin sensitivity, which improves insulin efficiency and decreases the levels which are needed for equivalent metabolic effect. Many researchers have found that cinnamon has a property that helps diabetic people gain insulin resistance. In order to control their blood sugar variations many diabetic people prefer to take cinnamon in their diet. More recently, scientific attention has also been paid to the insulin potentiating capabilities of cinnamon, which may prove beneficial for diabetic patients (Sangal, 2011). Chemicals in cinnamon have a special property to mimic the effect of insulin on the cells. This helps to maintain normal blood sugar level.

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