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## Effect of Spicy Fast Foods and Red Chili Powder on Liver Status of Hypercholesterolemic Rats

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### ABSTRACT

Young Saudi adults largely consume spicy fast food. Studies indicate chilies reduce cardiovascular diseases (CVD) and lipid profiles. The present study investigated the effect of spicy Saudi Arabian fast foods on liver status of hypercholesterolemic rats. Seventy male rats were equally divided into seven groups, all fed standard diets with or without modification. Negative controls were fed standard diet only, while the other six groups were fed an additional 2% cholesterol for 2 weeks to induce hypercholesterolemia. Then, three hypercholesterolemic groups were fed different doses of red chili (RC) extract (150, 300, and 600 mg/kg body weight), two were fed 30% broasted chicken or deep fried chicken nuggets of SD, and one remained on standard diet only (positive control). Compared to the positive control, all groups showed significant changes in lipid profiles except for very-low-density lipoprotein. All RC doses lowered cholesterol and low density lipoprotein levels relative to positive controls. However, those fed broasted chicken had a larger reduction in lipid profile ratios than RC groups. Nonetheless, 600 mg/kg of RC had the greatest impact on lowering lipid ratios. Moreover, high doses of RC extract lowered glucose, alkaline phosphatase, glutamate pyruvate transaminase, and glutamic-oxaloacetic transaminase levels the most. Spicy chicken elevated levels of those markers compared to RC groups. Yet, there is lowering trend goes opposite to doses of RC extracts in all liver functions. In conclusion, RC powder mixed with nonfatty food have a better effect on liver functions than consumption of RC in fatty, fried food. Although not advised, if the consumption of fast food is continued, adding RC is suggested as it could help lower the risk of CVD.

**Keywords:** red chilies, liver, hypercholesteremia, nuggets, chicken, spicy food

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## INTRODUCTION

Traditional Saudi cuisine merges several international food patterns, particularly in main cities and communities with different ethnicities. Major and important influence comes from subcontinental Asian countries and Far East foods, as well as Western style dishes with strong flavors, spices, and ingredients<sup>1</sup>. Although food patterns nowadays are far from healthy, many dishes are rich in chilies and spices, and a high percentage of the Saudi population, including young adults and teenagers, have gotten used to adding extra chilies to many meals consumed on a regular basis<sup>2,3</sup>. Recently, consumption of fast food with mixed spices has increased dramatically in Saudi Arabia. Recent studies have shown that consumption of chilies and other spices has increased double or more per capita<sup>2,4</sup>.

Almost all nutritional guidelines for a healthy diet recommend moderate consumption of a variety of items from multiple food groups and items, including food spices. For centuries, chilies and hot spices have been known to have medicinal and healing properties. Studies have indicated the health benefits of chilies and other spices include a reduction of cancer incidence rate, appetite and obesity, and cardiovascular diseases [CVD]<sup>5,6</sup>. In a human study, daily consumption of spices and chilies has been shown to contribute to a reduction in mortality rates in China associated with an inverse relationship between chili consumption and CVD, respiratory infections, and many cancers<sup>7</sup>. A mechanism by which hot chilies are suggested to exert their beneficial effects is through the main active constituent capsaicin, which has been shown to reduce cholesterol, triglyceride, and low-density lipoprotein (LDL) levels, leading to a reduction in liver damage<sup>8,9</sup>. The present study evaluated the effect of Saudi Arabian red chilies (RC) on liver status of hypercholesterolemic rats.

## MATERIALS AND METHOD

### **Animals and diets**

Samples of commercially made RC powder (*Capsicum frutescens*) and broasted chicken and deep fried chicken nuggets with RC pepper already integrated into the preparation were used. All of these foods were purchased from a local market in Makkah, Saudi Arabia. According to standard cooking methods and ingredients, 100 g of nuggets or broasted chicken prepared yields 300 or 600 mg of RC<sup>10,11</sup>.

Seventy male albino Sprague Dawley rats ( $185 \pm 8$  g each) were obtained from the Laboratory Animal Centre, Department of Biochemistry, Faculty of Medicine, Umm Al-Qura University (Makkah, Saudi Arabia). All animals were fed a standard diet consisting of casein (12.5%), corn oil (10%), choline chloride (0.2%), vitamin mixture (1%), cellulose (5%), salt mixture (4%), sucrose (22%), and corn starch (up to 100%) according to the National Research Council<sup>12</sup>. Then, they were divided into seven dietary groups ( $n = 10$  per group): negative control group

rats were fed standard diet only, while the other six groups received an additional 2% cholesterol for 2 weeks to induce hypercholesterolemia. Of the six hypercholesterolemic groups, one served as the positive control and remained on standard diet only, three were fed standard diet with different doses of RC powder extract [150, 300, or 600 mg/kg body weight<sup>13</sup> added, and two were fed standard diets with 30% broasted chicken or nuggets of SD. All procedures described were reviewed and approved by the Animal Care and Use Bioethical Committee of Medical Sciences, Umm Al-Qura University.

### **Blood collection and fat measurement**

At the end of 8 weeks and 24 h after the last feeding, blood samples were collected by euthanizing all rats in a chamber containing diethyl ether. Two blood samples were collected from each animal into a heparin containing and plane tube. For serum collection, blood samples in plane tubes were centrifuged at 3000 rpm for 10 min.

### **Biochemical measures**

Triglycerides and cholesterol were measured with enzymatic kits<sup>14, 15</sup>. High-density lipoprotein (HDL)-cholesterol (HDLC) was determined according to previous methods<sup>16, 17</sup>. The very-low-density lipoprotein (VLDL)-cholesterol (VLDLC) and LDL-cholesterol (LDLC) concentrations were calculated from the Reitman and Frankel equations [18]:  $LDLC = \text{Total Cholesterol} - (\text{HDLC} + \text{VLDLC})$  and  $VLDLC = \text{Triglycerides}/5$ . Various enzymatic colorimetric methods were used to determine blood glucose<sup>19</sup>, aspartate aminotransferase and alanine aminotransferase<sup>18</sup>, alkaline phosphatase (ALP) activity<sup>20</sup>, and total protein<sup>21</sup>.

### **Statistical analysis**

Data were expressed as means  $\pm$  standard errors of 10 experiments. In order to compare groups, analysis of variance was used. A paired-sample Student's *t*-test was used to compare parameters between the positive control and other hypercholesterolemic groups. A  $P < 0.05$  was considered statistically significant using the SPSS version 20 for windows.

## **RESULTS AND DISCUSSION**

### **Effect of RC on liver-to-body weight ratio**

Table 1 shows that only rats fed 600 mg/kg RC powder extract exhibited a significant liver-to-body weight ratio change compared to the positive control ( $P < 0.002$ ), while all other groups did not.

**Table 1: Effect of red chilies (RC) on liver-to-body weight ratio.**

Groups	Mean ± SE	ANOVA	
		F	Sig.
G I (C <sup>-</sup> )	2.15±0.086	4.6	0.002
G II (C <sup>+</sup> )	2.85±0.31		
	2.85±0.139		
G IV RC 300 mg/kg	2.74±0.090		
G V RC 600 mg/kg	2.7±0.081*		
G VI 30% Chicken of SD	3.25±0.306		
G VII 30% Negates of SD	3.48±0.188		

Positive control was compared statistically to all other hypercholesterolemic groups. \**P* < 0.05. SE, standard error; ANOVA, analysis of variance

### Effect of RC on lipid profiles

**Table 2** shows significant changes in cholesterol, HDLC, and LDL levels (*P* < 0.05 or 0.01) in rats fed 150, 300, and 600 mg/kg RC groups compared with negative controls; however, HDLC levels did not change significantly for the 150 mg/kg RC group. Rats fed 30% broasted chicken or nuggets also showed a significant change in HDLC (*P* < 0.05) compared to positive controls, whereas cholesterol, triglyceride, VLDL, and LDL levels did not change significantly in any groups.

**Table 2: Effect of red chilies (RC) on lipid profiles.**

Groups	Cholesterol	Triglycerides	HDLC	VLDL	LDL
	(mg/dL)	(mg/dL)	(mg/dL)	(mg/dL)	(mg/dL)
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE
G I (C <sup>-</sup> )	189.6±5.7***	146.6±11.6**	80.04±1.79**	29.33±2.32	80.23±4.22***
G II (C <sup>+</sup> )	255.2±10.1	225.8±7.31	52.56±4.43	45.17±3.46	157.4±9.71
G III RC 150	202.1±10.9*	195.4±11.68	64.56±7.99	39.07±6.34	98.38±7.59**
G IV RC 300	200.8±8.1**	186.6±6.79	71.00±3.45*	37.32±1.36	92.55±7.74**
G V RC 600	186.3±4.3**	195.1±4.34	75.06±2.13**	39.03±2.87	72.23±3.38**
G VI 30% Chicken	209.4±9.4	193.9±4.36	76.04±3.55*	38.79±2.87	94.52±7.58
G VII 30% Nuggets	228.3±5.7	205.9±5.56	78.16±5.69*	41.17±5.11	108.9±7.17
<b>ANOVA</b>					
<b>F</b>	6.112	1.575	4.380	1.576	9.111
<b>Sig.</b>	0.001	0.191	0.003	0.191	0.001

Data expressed as means ± standard errors; \**P* < 0.05, \*\**P* < 0.01. Positive control was compared statistically to all other hypercholesterolemic groups. ANOVA, analysis of variance; HDLC, high-density lipoprotein-cholesterol; VLDL, very-low-density lipoprotein-cholesterol; LDL, low-density lipoprotein

### Atherogenic index after RC ingestion

**Table 3** shows a significant change in LDL/HDL ratio for rats fed 300 and 600 mg/kg RC (*P* < 0.01) as well as 30% broasted chicken or nuggets (*P* < 0.05) compared to the positive control; however, the 150 mg/kg RC group did not show a significant change. In addition, the TC/LDL ratio showed significant changes for 150, 300, and 600 mg/kg RC and 30% broasted chicken

group ( $P < 0.05$  or  $0.01$ ). The 30% nugget group showed no significant change. Finally, the TC/HDL ratio significantly changed for 300 and 600 mg/kg RC and 30% broasted chicken ( $P < 0.05$  or  $0.01$ ), while 150 mg/kg RC and 30% nugget groups showed no significant change.

**Table 3: Atherogenic index after red chili (RC) ingestion.**

Groups	LDL/HDL Mean±SE	TC/LDL Mean±SE	TC/HDL Mean±SE
G I (C <sup>-</sup> )	1.00±0.039**	2.37±0.060**	2.37±0.055**
G II (C <sup>+</sup> )	3.07±0.307	1.63±0.055	4.95±0.357
G III RC 150	1.67±0.312	2.09±0.137*	3.32±0.406
G IV RC 300	1.32±0.137**	2.20±0.092*	2.85±0.166**
G V RC 600	0.96±0.045**	2.6±0.110**	2.47±0.017**
G VI 30% Chicken	1.24±0.066*	2.24±0.084*	2.76±0.085*
G VII 30% Nuggets	1.44±0.292*	2.19±0.145	2.99±0.339
<b>ANOVA</b>			
<b>F</b>	12.001	8.287	11.986
<b>Sig.</b>	0.001	0.001	0.001

Data expressed as means ± standard errors; \* $P < 0.05$ , \*\* $P < 0.01$ . Positive control was compared statistically to all other hypercholesterolemic groups. ANOVA, analysis of variance; LDL, low-density lipoprotein; HDL, high-density lipoprotein; TC, total cholesterol

#### Effect of RC on liver function

**Table 4** shows there was no significant change in glucose levels for RC 150 and 300 mg/kg RC and 30% broasted chicken and nugget groups, while 600 mg/kg RC showed a significant change ( $P < 0.05$ ). The same results were found for ALP and glutamate pyruvate transaminase. Other the other hand, no significant change in total protein was observed for any group. For glutamic-oxaloacetic transaminase (GOT), a significant change was observed for 300 and 600 mg/kg RC ( $P < 0.05$ ), but not for 150 mg/kg RC or 30% broasted chicken or nugget groups.

**Table 4: Effect of red chilies (RC) on liver function.**

Groups	Glucose mg/dL Mean±SE	T. protein g/dL Mean±SE	ALP U/L Mean±SE	GPT U/L Mean±SE	GOT U/L Mean±SE
G I (C <sup>-</sup> )	87.69±4.95**	6.80±0.412	222.4±7.42**	30.38±2.9**	31.45±5.2*
G II (C <sup>+</sup> )	134.9±18.29	8.35±1.172	585.3±45.16	48.70±0.768	44.44±0.864
G III RC 150	107.8±12.14	8.06±0.889	424.4±82.75	41.81±5.322	32.41±4.513
G IV RC 300	104.9±17.24	9.18±0.636	424.1±54.41	34.79±5.06	30.51±5.41*
G V RC 600	92.1±16.59*	8.6±2.147	373.3±31.51*	29.45±2.78**	25.73±2.5**
G VI 30% Chicken	129.4±20.27	9.54±0.963	512.6±68.68	49.60±0.678	45.10±1.018
G VII 30% Nuggets	122.0±30.42	8.45±1.778	390.6±95.74	48.40±0.927	44.04±1.181
<b>ANOVA</b>					
<b>F</b>	0.957	0.471	3.400	7.676	5.281
<b>Sig.</b>	0.471	0.824	0.012	0.001	0.001

Data expressed as means ± standard errors; \* $P < 0.05$ , \*\* $P < 0.01$ . Positive control was compared statistically to all other hypercholesterolemic groups. ANOVA, analysis of variance; ALP, alkaline phosphatase; GPT, glutamate pyruvate transaminase; GOT, glutamic-oxaloacetic transaminase

## DISCUSSION:

Spicy foods have been consumed by many cultures for over 4000 years. Traditional Chinese and Indian cuisines are famous for spicy dishes. In Saudi Arabia, consumption of spicy foods has increased over the years, especially in fried fast foods. The present study evaluated the effect of RC powder extract on a standard diet or combined with deep-fried fast food on hypercholesterolemic rat models. Studies around the globe have shown conflicting effects of red pepper or chilies on health<sup>22</sup>, particularly with respect to liver damage<sup>8</sup>. Nonetheless, there is much evidence supporting their beneficial effect on the function and structure of various tissues and organs in humans and animals, as in the current study. In fact, the main active constituent in hot chilies, capsaicin, has been shown to affect lipid profiles and reduce liver damage<sup>8,9,23,24</sup>. Herein, RC powder extract mixed with a standard diet had best effect on liver function and structure compared to deep fried food with RC integrated into the recipe.

While all groups that consumed RC had different liver weights than the positive control, only the highest dose of RC (600 mg/kg) offered a significant change. Likewise, Kim *et al.*<sup>9</sup> also found a change in liver size in rats. The change in weight with RC consumption can be explained in the light of the fact that capsaicin has been shown to significantly decrease liver size by reducing hepatocyte inflammation as well as fat content. On the other hand, another study in rabbits reported the histopathological structure of cells showed an increase in the size of blood veins and fluid congestion, causing an increase in liver size<sup>25</sup>. In contrast, the size of livers in rats fed fast food containing RC in the present study were bigger than both negative and positive controls. The high fat content of deep fried fast food can increase insulin secretion, increasing fat stored in the liver.

Regarding lipid profiles, all groups in the current study show some changes relative to the positive control though not always significantly. However, VLDL levels did not differ much in any group compared to the positive control, in contrast to some previous studies<sup>26,27</sup>. Here, addition of RC to the standard diet caused a significant concentration-dependent decrease in cholesterol and LDL but an increase in HDL. Furthermore, increases in cholesterol, LDL, VLDL, and a significant increase in HDL was observed with consumption of broasted chicken and nuggets compared to positive control. Similar findings have been reported previously<sup>25–27</sup>. Of note, the current study used much higher concentrations of RC than Al-Jumayi *et al.*<sup>25</sup> [150–600 mg/kg versus 5–10 mg/kg, respectively]. This difference between studies demonstrates two key points. First, that at higher doses, the beneficial effects of RC are even better, as long as the animal can tolerate it throughout the experimental period. Tolerance of RC ingestion is important as many animals and humans are not used to consuming moderate

to higher doses of spice in foods<sup>28</sup>. Second, consumption of lower doses of RC may still be beneficial to some extent along with a healthy diet.

With respect to ingestion, bioavailability must be considered. Use of pure capsaicin would equate to a high dose compared to consumption of natural and complete RC peppers<sup>28</sup>. Likewise, fried food like nuggets and broasted chicken have many more components that could reduce the availability and activity of the capsaicin in RC even more so than components found in a healthy diet. This might explain the low/absence of effect of certain spicy foods on lipid profiles or other liver functions.

The anti-atherogenic effect of RC consumption found in the present study is encouraging as LDL/HDL and TC/HDL ratios were lower than the positive control, with only a slight increase in TC/LDL ratio. The greatest effect occurred with 600 mg/kg RC. Moreover, these significant, beneficial changes also occurred with consumption of spicy broasted chicken. These positive results are similar to those found in previous studies<sup>26, 29</sup>. Importantly, the poor LDL/HDL ratio, which increases the risk of CVD, exhibited by the positive control was lowered significantly by consumption of RC as part of a standard diet or in fast food. Such RC effects could be the result of various mechanisms, such as the activation effect of capsaicin on hepatocytic cell receptors, like proliferator-activated receptor  $\alpha$ . At the physiological level, absorption of cholesterol could also be reduced in the intestine, with more cholesterol combining with bile salts and being excreted<sup>24, 30, 31</sup>.

In terms of liver function, the current study measured glucose, GOT, ALP, and glutamate pyruvate transaminase levels. Apart from total protein, all measures in all groups were significantly different from that of the positive control. However, 600 mg/kg RC lowered glucose, ALP, glutamate pyruvate transaminase, and GOT levels the most. Al-Jumayi *et al.*<sup>25</sup> reported the same effect, with lowered alanine aminotransferase, aspartate aminotransferase, and bilirubin compared to the control. Though they did not measure glucose levels, lowered glucose with RC consumption was also reported in rabbit models<sup>23</sup>. A reduction in glucose levels can be explained by inhibition of certain enzymes involved in glucose metabolism, like  $\alpha$ -amylase and  $\alpha$ -glucosidase<sup>32, 33</sup>. Other mechanisms could be related to increased insulin sensitivity and improved glucose tolerance<sup>34</sup>.

## CONCLUSION:

The current study found that consumption of enough RC with a standard/healthy diet or as ingredient of deep fried fast food has a positive effect on lipid profiles, reducing cholesterol, triglycerides, and LDL and increasing HDL, as well as liver function, decreasing glucose, GOT, and alanine aminotransferase. However, consumption of RC with a standard/healthy diet

had the most beneficial effects. Thus, it is recommended that more RC powder be consumed with meals.

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