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Abstract:

Hypercholesterolemia is the major risk factor for cardiovascular diseases, thus, this current study held to explore the positive effects of kumquat and Limon (peel and whole) adiposity and biochemical parameters in rats with hypercholesterolemia, as well as assessed the sensory properties of baked cookies containing 5% doses of kumquat and lemon(both peel and whole) **.** Thirty male albino rats were administered a basal diet as (control negative -ve) group of 5 rats each ; group (2) administered on hypercholesterolemic diet and the remaining groups(3th,4th,5th,6th) administered diet containing 5% kumquat and5% lemon (both peel and whole) with hypercholesterolemic diet for four weeks. Serum cholesterol and triglycerides, LDL,VLDL,HDL/LDL ,Moreover, ALT,AST, creatinine and uric acid were significantly decreased in groups supplemented with kumquat and Limon (peel and whole) at 5% . Therefore, kumquat and limon may consist of a valid strategy of phenolic compound which can be used in controlling hypercholesterolemia and its harmful consequences and enhance renal function in hypercholesterolemic rats. Also, sensory evaluation results revealed that cookies prepared with kumquat and Limon (peel and whole) at 5% were accepted by panelists with different ratings.

Key words: Citrus fruits, Limon, Kumquat, Dyslipidemia, Adiposity.

Introduction:

Cardiovascular disorders (CVD) that increase the production of reactive oxygen species (ROS) in the blood and tissues are most commonly caused by hypercholesterolemia (**El Tantawy, 2015 and Baldissera *et al*., 2017**). Foods high in phytochemicals are regarded as a way to preserve excellent health in addition to providing nutrients for healthy body operation. Because orange peel is an industrial byproduct of the fruit processing industry, special focus was given to illuminating its health-promoting properties. Citrus fruits (high concentrations of phytochemicals and bioactive substances) are responsible for their health advantages (**Toth *et al*., 2016).**

When consumed in moderation, the poly methoxylated flavones present in citrus peels may decrease total and LDL cholesterol without having the negative side effects associated with conventional cholesterol medications. Findings by **Dayse *et al*. (2022)** suggest that kinkan orange may be utilised as an adjuvant in lipid problems and may be a diet that protects the heart.

Citrus fruits L. (*family Rutaceae*), according **to Giglio *et al*. (2016),** protect against free-radical damage and increase high density lipoprotein cholesterol (HDL-C). Originally from China, kinkan orange (*Fortunella japonica*) is a good source of dietary fibre as well as a variety of bioactive substances, including as ascorbic acid, terpenoids, carotenoids, flavonoids, and essential oils (**Lim ,2012**).

These plants are extremely valuable as medicines since they contain a variety of chemical compounds that have physiological effects on people. Alkaloids, flavonoids, glycosides, saponins, resins, oleoresins, sesquiterpenes, phenolic compounds, and oils are only a few of the chemical components found in medicinal plants (**Devanooru *et at*., 2015).**

Hesperidin, a flavonoid found in lemon peel and pulp, lowers triglycerides and cholesterol. In a study conducted in collaboration with the US Department of Agriculture, compounds that isolated from lemon peels showed promise in animal studies as a potent natural alternative for lowering LDL cholesterol. These compounds lack the potential side effects of conventional cholesterol-lowering medications, such as liver disease and muscle weakness. Lemon peel is also a source of pectin, a natural fibre that lowers cholesterol levels (**Sohn *et al*., 2016 and Pultrin *et al*., 2017).**

The smallest member of the Rutaceae family of real citrus fruits is the kumquat (*Fortunella margarita Swingle*). Fruit is consumed with the peel or added to drinks since the flesh is sour. The minerals and phytochemicals found in kumquats are likewise very high quality. Kumquats work well in a variety of items **(Wang *et al*., 2012; and Peng *et al*., 2013).**

Given this, the current experiment was created to examine the value of lemon and kumquat (peeled and whole) fruits as preventative measures against various lifestyle-related diseases including hypercholesterolemia.

Materials and Methods:

Materials

Kumquat fruits and lemon(*citrus limon and citrus japonica*)were purchased from Agriculture research center, Cairo, Egypt.

Cholesterol, bile salts and casein were purchased from El-gomhoriya Pharm. and Chem. Ind. Comp., Cairo, Egypt.

RATS: The Ministry of Health and Population, Helwan, Cairo, Egypt, provided thirty male adult albino Sprague Dawley strain rats (140±10g each). Wire cages with controlled environments were used to house the rats. As a week-long adaptation phase, rats were provided a regular meal. Rats were given their diet in specialised feeding containers to prevent food spillage. Additionally, glass tubes extending through the wire cages from an upside-down bottle held on one side of the cage were used to deliver water to the rats. Ad-labitum food and drink were given and monitored every day.

Methods

The *citrus limon* and *citrus japonica* were cleaned, peeled, and dried in an oven at 50°C for four days until completely dry. The same procedure was used with entire fruits as well. Powders were created by grinding the dried fruit and peels. Glass jars containing the powdered citrus peel and fruit were maintained in the refrigerator at 4°C for examination. (**IZLI *et al*., 2018) .**

Hypercholesterolemic induction:

By combining 2.5% cholesterol and 2% animal saturated fat with the typical baseline diet, a high cholesterol diet for the induction of hyperlipidemia was created. Carefully installed in the cage, the food was fed for 4 weeks (**Pandya *et al*., 2006**).

Determination of total phenolic and flavonoids:

The Folin-Ciocalteu micro-method was used to quantify the total amount of phenol in the sample **(Saeedeh and Asna, 2007**). The approach of using the total flavonoid content as method by (**Ordon *et al*., 2006).**

Design of the experiment

Albino adult male Sprague Dawley strain rats were randomly assigned to one of two main groups: the negative control group (first group) (n=5), which received a basal diet; and the hypercholesterolemic group (n=25), which received a basal diet (**Reeves *et al*., 1993**)and was divided into five subgroups: the second group (positive group), as well as the third, fourth, fifth, and sixth groups, which received peels and whole fruits at a level of 5% for both kumquat and limon substituted from corn starch (*citrus limon and citrus gaponica)* .

Rats were fasted overnight and given anesthesia before the experiment was over. Each group's retro-orbital plexus was used to draw blood samples, which were then placed in sterile, dry tubes with labels. Heparin, an anticoagulant, was present in the tubes. Plasma was extracted from blood by centrifuging it at 3500 rpm for 15 min. The plasma was then carefully stored in tubes at -20°C for the completion of the biochemical analysis. The liver and kidney were weighed in addition to measuring the weight increase and feed intake of the rat groups in order to estimate the feed efficiency ratio (FER).

Biochemical assay:

Serum glucose was determined using kits supplied by Bio-diagnositic laboratory reagents and products according to the method of **Trinder (1969**), triglycerides in serum and Serum total cholesterol were determined according to **(Fossati and Prencipe, 1982).**

According to **Wieland and Seidel, (1981**), high density lipoprotein cholesterol (HDL-C) was measured, and low density lipoprotein cholesterol (LDL-c) was measured using the method of (**Lee and Nieman, 1996).** , The blood uric acid was determined using **Caraway's technique (1955**), and the serum creatinine level was determined using the method of (**Bohmer, 1971**). **Reitman and Franke (1957**) recommended measuring serum alkaline phosphatase (ALP), whereas **Roy, (1970)** recommended measuring aspartate aminotransferase and alanine aminotransferase (AST and ALT).

Sensory evaluation:

Preparation and sensory evaluation of cupcakes:

According to **Dubat (2010),** the dry components for cupcakes were eggs, flour, baking powder, dried skim milk, and vanilla. These ingredients were stirred together, and then sugar and salt were added to a medium mixing bowl. For all mixing operations, a handheld electric mixer was utilized. After creaming the margarine for 1 minute, sugar and salt were added, and the mixture was then continued for another minute. A third of the dry mixture and water were added, and all of this was combined for 45 seconds before being added to the creamed mixture. This process was done again. The metal cup was filled with the batter. The cooked cupcakes were allowed to cool completely at room temperature before being sealed in aluminum foil bags and kept chilled. Likewise concurrently made available to the panelists. Ten members of the panel were asked to rate several samples for color, taste, aroma, texture, and overall quality on a 9-point hedonic scale (**Moretti *et al*., 2004).**

Statistical analysis:

The replicated results were presented as mean standard deviation according to **McCormick and Jesus (2017**) The least significant difference and a one-way analysis of variance (ANOVA) were used. At ($P<0.05$), significance was accepted.

Results and discussion:

According to **Mithun *et al.* (2022**), the high concentration of polyphenolic content in fruits and vegetables increases antioxidant activities and shields cell constituents from oxidative damage and a number of degenerative conditions linked to oxidative stress, including cardiovascular conditions, diabetes mellitus, and neurodegenerative conditions (**Ghasemi *et al.*, 2009)**,Thus from table (1) The total phenolic contents and flavonoid varied among the two citrus species tested (*limon and japonica*) .The limon (W and P) having the higher total phenol content while japonica (W and P) had the higher total flavonoid content. However, none of the readings were higher than previously reported levels (**Ademosun and Oboh 2012).** Additionally, it was noted that the flavonoid concentration of certain Brazilian citrus species was higher in the fruit peels than the liquids (**Pereira *et al*. 2017**).

The total flavonoids, however, were shown to be lower than those listed by **Wang *et al*. (2008).** Dried kumquat peel in our result contained 0.013 QE g^{-1} flavonoids. Another study by **Wang *et al*., (2008)** reported that total flavonoids in dried kumquat peels were 41.0 mg/g, db (rutin equivalents). This difference between the obtained results and the previous results (**Sadek *et al.*, 2009 and Ramful *et al.*, 2011**) might be due to different environmental conditions.

Dried whole kumquat had the highest F/P ratio compared to the peel, table(2) assessed the phenolic, flavonoid acid rich of kumquat , one of the plant foods, for its beneficial effect on lowering plasma lipid profile in (Table 3,4,) as maintained by another study by (**maria *et al.*, 2022).**

Table (1) The total phenolic and total flavonoid in citrus japonica and Limon (P and W) samples

samples	T phenolic mgGAE/g-1	T Flavonoids mg QE / g-1
lemon p 5%	**0.26**	**0.078**
kumq p 5%	**0.28**	**0.041**
lemon W 5%	**0.64**	**0.063**
kumq W 5%	**0.49**	**0. 053**

Gallic acid equivalent (GAE)
Quercetin equivalent (QE)

Table (٢) biological evaluation of hypercholesterolemic rats (+ve) positive group compared to the (-ve) negative control group, exhibited a substantial increase in feed intake, body weight gain percentage, and feed efficiency ratio at($P<0.05$), feeding 5% of limon and japonica(peel and whole) on feed intake, feed efficiency ratio and body weight gain of hyperlipidemic rats are also shown in Table (1).

Concerning the feed intake, it was highly significant increase as 15.83±1.01g/day for negative control and 19.02±1.90 g / day for positive control group. However, the feed intake for groups 3, 4 5 and 6 significantly decreased at (P<0.05) as compared to positive control group. For body weight gain, the mean levels significantly decreased at (p< 0.05) gradually for groups 3, 4, 5 and 6. There are no significant changes between 3 and 4 group and the negative control group .For FER, the all group was decreased significantly when compared with the positive group ,this decreases were all statistically significant (P<0.05).

These outcomes were consistent with **(Dayse *et al.*, 2022)** who discovered that hypercholesterolemic diets had greater caloric densities than control diets, increasing body weight (P<0.0001) and relative liver weight, which was supported by increased adiposity. Additionally, our findings supported earlier research that suggested a diet high in 1% cholesterol causes weight growth (**Abreu *et al.*, 2014**).

The results of the recent investigations were consistent with those of **Abdelbaky *et al.* (2009**), who examined the impact of lemon peel powder on biochemical parameters in hypercholesterolemic rats and reported a significant decrease in the ratio of body weight gain in the citrus peel-supplemented group of rats compared to the control group. The increase in liver weight of the hyperlipidemic control group is the cause of the treated rats' weight loss. This could be explained by the control group's high rate of hepatic cholesterol production. There was no significant difference among negative control (2.33±0.12) and groups 3, 4,5and 6 in liver weight. Also, However, the kidney weight for negative control group was 0.57±0.022g, there was no significant difference between negative control group (-) and groups3 , 4,5and 6.These results are in accordance with those of (**Abdelhaliem and sheha, 2018)** who reported that lemon peels protected the organs as liver and kidney from toxins and damage.

We found that supplementation with 5% kumquat orange did not affect the caloric density of diets and reflected in the similar results of limon peel in food and energy intake, body weight, liver relative weight and adiposity index in control groups(**Dayse *et al.*, 2022**).

Table (2) biological evaluations of rats fed on citrus Limon and Japonica (peels and whole) at 5% (Mean ± S.D)

groups	feed intake g/d	BWG g/weeks	FER %	liver W g%	kidney w g/%
negative control	15.83 ± 1.01[b]	46.18 ±3.31[b]	0. 104 ±0.006[b]	2.33 ± 0.12[b]	0.57 ± 0.022[b]
positive control	19.02 ±1.90[a]	62.41 ±2.07[a]	0.123 ±0.016[a]	3.38 ±0.15[a]	0.74±0.35[a]
lemon p 5%	14.24±1.20[b]	44.6 ±2.07[b]	0.108±0.006[b]	2.5 ±0.10[b]	0.60 ±0.017[b]
kumq p5%	13.99 ± 1.03[b]	42.1 ±2.2[b]	0.107 ±0.007[b]	2.4 ±0.07[b]	0.60 ±0.013[b]

lemon W 5%	**12.2 ±0.23[cb]**	**36.2 ±1.87[b]**	**0.106 ± 0.005[b]**	**2.6± 0.14[b]**	**0.63 ±0.022[b]**
kumq W 5%	**11.09 ±1.10[bc]**	**33.4 ±2.3[bc]**	**0.107 ±0.008[b]**	**2.36 ± 0.05[b]**	**0.64 +0.05[b]**

The value in each column with different superscript are significant at ($p<0.05$).

Table (3) revealed the effect of adding 5% levels of kumquat and limon (W and P) on serum lipid profile in hypercholesterolemic rats. Hypercholesterolemic groups administrated with 5% kumquat (whole) represented the highly significant at ($P<0.05$) improvement percentage in serum (CHO, TG, LDL and VLDL) compared to positive control group. While high density lipoprotein (HDL) was elevated significantiy at ($P<0.05$) with 5% kumquat (whole), followed by 5%limon (whole), 5% kumquat (peel), 5% limon(peel) group respectively compared to positive group. These results agree with those of other researchers (**Lien *et al.*, 2009 and jing-li *et al.*, 2013**), who suggested that the flavonoids may once again be a key mediator of the effectiveness. Rats' serum cholesterol and triglyceride concentrations have already been shown to decrease with increasing phenolic compound intake. Moreover, Citrus peel was investigated as a regulator of lipoprotein metabolism in rats against diet-induced fatty liver by **(Park *et al.*, 2011).** Additionally, **Mollace *et al.* (2011**) noted noteworthy.

Citrus peel bioactive molecules activate receptor cells so that extra LDL and triglycerides are incorporated into liver and adipose tissue instead of circulating in the circulatory system and forming hard plaque. This hypothesis was affirmed by **Wang *et al.* ,(2011),** who summarized that hesperidin (bioflavonoid found in a variety of nutritional supplements that have various beneficial effects on blood vessel disorders) has potential to prevent fatty degeneration of liver thus control hepatic lipid metabolism

According to **Choi, (2005) and Sadek et al. (2009),** dietary fibre and phenolic compounds, which replace cholesterol and slow down the hydrolysis of cholesterol esters, may also be primarily responsible for these outcomes by lowering the absorption of dietary and biliary cholesterol in the small intestine (**Jesch and Carr, 2017**). Bile acids would become unavailable as surfactants in the small intestine due to the binding to dietary fibre and phenolic compounds. This would interfere with lipid emulsification, the formation of mixed micelles, the complete digestion of lipids, and their absorption, lowering levels of circulating triglycerides and the bioavailability of lipophilic nutrients (**Capuano, 2017).**

Mulvihill *et al.* (2009) found that LDL Receptor- Null Mice had decreased hepatic carnitine palmitoyl-transferase 1α (CTP-1α), peroxisome proliferator-activated receptor gamma coactivator 1-alpha

(PGC-1α), and fatty acid oxidation in response to a western diet high in fat and sodium and low in fruits and vegetables. The flavonoid produced from citrus raised PGC-1α gene expression, which in turn increased mitochondrial DNA, facilitated fatty acid oxidation, and reduced triglyceride buildup in the liver. Citrus flavonoids' strong inhibition of hepatic apo B secretion has been attributed as the mechanism by (**Lin *et al.* 2011**).

Table (3) Effect of citrus limon and japonica (peels and whole) on lipids profile of the hypercholesterolemic rats (Mean±S.D)

groups	TC mg/dl	TG mg/dl	HDL mg/dl	LDL mg/dl	VLDL mg/dl
negative control	92 ±3.73[d]	74.4 ±4.9[c]	45.4 ±2.8[a]	31.8±3.4[d]	14.8±1.9[c]
positive control	198.5± 9.9[a]	163.8 ± 5.07[a]	16.4±1.5[c]	149.3 ±6.8[a]	32.8±2.8[a]
lemon p 5%	140.36 ±11.4[b]	102.2 ±3.6[b]	34.4 ±3.8[b]	85.2 ±5.2[b]	20.4±2.1[b]
kumq p5%	137.56 ± 6.5[b]	94.2 ±4.9[b]	36.8 ±3.5[b]	81.96± 7.8[b]	18.8±1.8[b]
lemon W 5%	119 ±5.07[c]	90.1±5.00[b]	37.6±3.7[b]	63.4 ±6.1[c]	18.0±1.7[b]
kumq W 5%	116 ±4.00[c]	87.4 ±3.88[b]	35.7 ±3.99[b]	62.8±5.9[c]	17.5±1.8[b]

The value in each column with different superscript are significant at ($p<0.05$).

The effects of 5% levels of kumquat and Limon (whole, and peel) on the TC/HDL ratio and LDL/HDL ratio in hypercholesterolemic rats were demonstrated by the data in table (4). Generally, all treatments enhanced the HTR and LHR to a level expected of healthy rats. In the hypercholesterolemic groups, the diet supplemented with 5% whole kumquat and lemon was found to be the most effective therapy for lowering HTR and LHR significantly at ($P<0.05$). These results coroborated those of **Abdel Haliem and Sheha (2018),** who noted the similar tendency.

It has been established that the phenolic and flavonoid chemicals have hypocholesterolemic effects via controlling hepatic gene expression involved in lipid metabolism (**Jung *et al.*, 2012**). As a result, phenolic substances as well as the flavonoids in table (2) may contribute to the lipid-lowering properties of the whole kumquat. The risk of coronary heart disease was negatively correlated with the HDL: TC (HTR %) ratio (**Rajendra and Estari, 2013**).

Atherogenic indices are effective predictors of the likelihood of getting heart disease; calculated using the formula log (TG/HDL-C), as a marker of plasma atherogenicity based on a positive association with the lipoprotein particle size, cholesterol esterification rates, and remnant lipoproteinemia (**Quispe, 2015**). The data obtained have revealed that both the peel and the whole kumquat have anti-atherogenic properties. According to this study, the whole kumquat has hypocholesterolemic properties, which may once more be mediated by flavonoids and phenolic substances (**Jung et al., 2012**).

Table (4) Atherogenic index (LDL/HDL, TC/HDL) of rats fed on citrus limon and japonica (peels and whole) at 5% (Mean ± S.D)

groups	LDL/HDL	TC/HDL
negative control	0.70±0.01[c]	2.03±0.07[c]
positive control	9.11±0.90[a]	12.10±1.21[a]
lemon p 5%	2.47±0.09[b]	9.08±0.19[b]
kumq p 5%	2.23±0.08[b]	3.73±0.33[b]
lemon W 5%	1.68±0.05[b]	3.16±0.13[b]
kumq W 5%	1.76±0.06[b]	3.25±0.29[b]

The value in each column with different superscript are significant at ($p<0.05$).

In hypercholesterolemic rats, the current study demonstrated the impact of kumquat and limon on liver and kidney functions in table (5). We discovered that, as previously reported, hyperlipidemia was accompanied by an increase in the quantity of liver damage caused by an significant increase in serum ALT (**Abreu *et al.*, 2014 and Ben Gara *et al.*, 2017).** Kumquat and limon intake in hypercholesterolemic condition was represented by decreased blood AST, ALT, urea, and creatinine levels significantly at ($P<0.05$), suggesting a potential protective impact on liver function. These results suggested that kumquat phenolic compounds may be effective liver protectants against hypercholesterolemic toxicity, primarily by reducing oxidative stress and enhancing metabolic profile

In comparison to the negative control group, all groups had greater values; the creatinine levels of all groups displayed a high significant difference when compared with negative control group. Also, the uric acid level in the negative control group was 1.31± 0.06 mg/dL and there were no significant differences in the plasma uric acid of groups 2, 3, and 4 as compared with negative group. The outcomes are consistent with those of **Abdelhaliem and Sheha (2018**), who claimed that supplementing with lemon peel at low dosages over an extended period of time can enhance kidney functioning.

Table (5) Effect of kumquat and limon (peel and whole) at 5% on serum kidney and liver parameters of the hypercholesterolemia rats(Mean ± S.D)

groups	uric acid mg/dl	Creatinine mg/dl	AST U/L	ALT U/L
negative control	1.31 ±0.06[c]	0.67 ±0.05[c]	52.24 ±2.9[c]	36.62 ±2.6[c]
positive control	3.19 ±0.48[a]	1.99 ±0.03[a]	77.46 ±3.8[a]	55.48 ±2.04[a]
lemon p 5%	2.28±0.12[b]	1.27 ± 0.41[b]	67.14±2.9[b]	44.84 ±2.13[b]
kumq p 5%	2.29±0.04[b]	1.26 ± 0.04[b]	59.59 ±1.9[c]	44.32 ±2.6[b]
lemon W 5%	2.2 ± 0.07[b]	1.3±0.08[b]	55.96 ±3.7[c]	45.24±2.9[b]
kumq W 5%	2.35 ±0.15[b]	1.25 ± 0.09[b]	56.54 ±2.5[c]	43.02 ±2.6[b]

The value in each column with different superscript are significant at ($p<0.05$).
AST: aspartate aminotransferase ALT: alanine aminotransferase

Sensory evaluation:

From table (6) data revealed that colour , appearance, taste , texture and overall quality of cupcake with limon(peel) at 5% had nearest score to the control cake with wheat flour ,followed by kumquat (peel) at 5%, lemon W 5% and kumquat W at 5% levels.

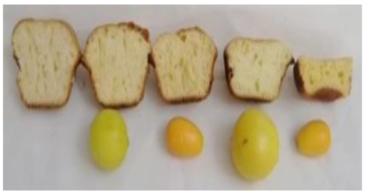
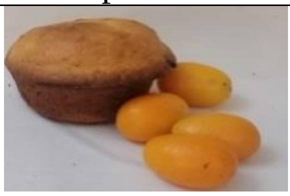
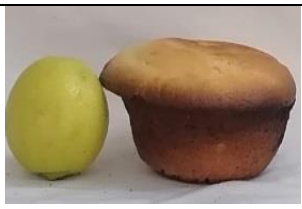
After the enrichment, the cupcakes took on a more bitter taste, which means that the presence of these ingredients might have influenced the taste of the final products due to the presence of bitter-tasting compounds typically found in the fibrous component of the lemon peel. Thus, results indicated that the incorporation of lemon processing by-products allowed the production of functional enriched cupcakes with improved antioxidant properties (**Valeria *et al*., 2021).**

Table (6): sensory evaluation (colour, taste, texture, appearance and overall quality) of cake of kumquat and limon (peel and whole) at 5% (Mean ± S.D)

Cake samples	Color	Appearance	Texture	Taste	Overall Quality
control	9.8±0.44	9.1± 0.33	9.6±0.48	9.5±0.52	9.5±0.54
lemon p 5%	9.1±0.29	8.7±0.5	8.5±0.50	8.9±0.33	8.8±0.53
kumq p5%	8.4±0.52	7.9±0.60	7.2±0.67	7.7±0.50	7.8±0.56
Lemon W 5%	7.9±0.60	7.6±0.48	7.6±0.50	7.7±0.59	7.7±0.54
kumq W 5%	7.5±0.66	6.9±0.33	6.5±0.47	7.8±0.53	7.2±0.67

The low volume of cupcake affects the texture of cake negatively. Our findings of sensory attributes of cake are in accordance with findings of **Mrabet *et al*. (2016**) who reported sensory attributes of muffins enriched with fruit fiber. According to them enrichment of fiber in muffin is acceptable upto a limit after that fiber enriched product got lower marks by panelist. But average results showed that all the treatment had good scores, between 6 and 8 on a 9-point scale.

So, with regard to the effect of addition lemon and kumquat on the sensorial properties it could be concluded that addition of lemon and kumquat at the level of 5% have an improvement of cupcakes quality and were also accepted by the panelists.These data were nearly in accordance with those given by **Abozeid *et al*., (2011**),who stated that 10% of orange peel and pulp could be incorporated as an ingredient in making biscuits and cakes , as they are a suitable source of dietary fiber with associated bioactive compounds (Flavonids, Carotenoids etc.).

 Slides of samples show pores	 Photo(1a) Control	 Photo(1b) lemon p 5%
 Photo (1c) kumquat p5%	 Photo(1d) lemon W 5%	 Photo (1e) kumquat W 5%

All samples

Conclusion

In rats, given a hypercholesterolemic diet, dietary supplementation with 5% of kumquat and lemon (peel and whole) improved lipid profiles and exhibited a protective impact against oxidative damage and renal function. Our findings point to kumquat and lemon as a possible meal for cardiovascular protection and as an adjuvant in lipid disorders.

Enriched cupcakes showed higher polyphenol content and antioxidant activity than the control one, with suitable acceptability evaluated by the consumers through the preference test.

It may be concluded that lemon peel could be incorporated in the formulation of cupcakes increasing their bioactive compounds content without affecting their overall appearance, resulting in acceptable products and with improved functional andNutraceutical properties. In this view, innovative uses of food wastes, rich in phenolic, can lead to an increase in the production of food with suitable nutritional characteristics and to satisfy customers’ expectations of healthy.

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المستخلص العربي:

زيادة كوليسترول الدم هو عامل الخطر الرئيسي لأمراض القلب والأوعية الدموية، وبالتالي، تهدف الدراسة الحالية الى تقييم تاثير اضافة الكيمكوات والليمون (كامل وقشر) على النمو والسمنة و,الاختبارات البيوكيميائية الحيوية في الجرذان المصابة بفرط كوليسترول الدم، بالإضافة إلى تقييم الخصائص الحسية لملفات تعريف الارتباط المخبوزة التي تحتوي على جرعات ٥٪ من الكمكوات والليمون (كامل وقشر) تم تغذية ثلاثين من ذكور الجرذان البيضاء بنظام غذائي أساسي كمجموعة (سيطرة) مكونة من ٥ جرذان لكل منهما ؛ تتغذى المجموعة (٢) على نظام غذائي عالي الكوليسترول والمجموعات المتبقية (٣، ٤، ٥، ٦) على نظام غذائي يحتوي على ٥٪ من الكمكوات والليمون (كامل وقشر) مع نظام غذائي عالي الكولسترول لمدة أربعة أسابيع، انخفض مستوى الكوليسترول والدهون الثلاثية في الدم ، والدهون منخفضة الكثافة والمنخفضة الكثافة جدا وعلاوة على ذلك انخفضت انزيمات الكبد مع الكرياتنين وحمض البوليك، انخفاضًا كبيرًا في المجموعات المكملة بالكيمكوات والليمون (كامل وقشر) بنسبة ٥٪. لذلك ، قد يتكون فكرة عن كون الكيمكوات والليمون من كاستراتيجية جيدة من الفينولات التى يمكن استخدامها في السيطرة على فرط كوليسترول الدم وعواقبه الضارة وتعزيز الحماية الكلوية في الفئران المصابة بفرط كوليسترول الدم. كما أوضحت نتائج التقييم الحسي أن البسكويت المحضر من الكمكوات والليمون (كامل وقشر) بنسبة ٥٪ تم قبوله من قبل أعضاء المحكمين بتقييمات مختلفة.

الكلمات المفتاحية: فواكه حمضية، ليمون كيمكوات، تلخبط فى دهون الدم، السمنة.