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MONOSODIUM IODOACETATE-INDUCED ARTHRITIS IN RATS**

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Research Journal Specific Education

**Faculty of Specific Education
Mansoura University**

ISSUE NO. 66, APRIL , 2022

**مجلة بحوث التربية النوعية - جامعة المنصورة
العدد السادس والستون - أبريل ٢٠٢٢**

EFFECT OF FRUIT ICE-CREAM ENRICHED WITH TURMERIC, BEE POLLEN ON MONOSODIUM IODOACETATE-INDUCED ARTHRITIS IN RATS

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Abstract:

Health disorders in the skeleton and spine occur as a result of inflammation that affects the joints, due to not following a proper diet. These infections can also be reduced by using fortifying foods such as foods rich in antioxidants, minerals and vitamins as defense factors, as fruits are a rich source of vitamins and minerals. It has been proven that tangerines and apricots have a powerful antioxidant effect. **The objective** of this research was to study the effect of ice-cream enriched with fruits (Tangerine or apricot), turmeric and bee pollen on Monosodium Iodoacetate-Induced arthritis. Six samples of fruit ice cream were prepared as follows; (Tangerine ice cream, tangerine turmeric ice-cream, tangerine turmeric bee pollen ice cream, apricot ice cream, apricot turmeric ice-cream and apricot turmeric bee pollen ice-cream) Next to three other samples which are bee pollen with olive oil, bee pollen with bee honey and bee pollen with bee honey and turmeric. Chemical composition was determined, Levels of serum calcium, vitamin D, ROS, MID, antioxidant enzymes and joint image analysis were assessed, **Methods:** Fruit ice cream was prepared by adding of fresh fruits (tangerine or apricot) at 70 %; Fruit turmeric ice cream (1.5 % turmeric); Fruit turmeric pollen ice cream (1.5 % turmeric and 7% bee pollen). All mixtures were chemically and sensory evaluated. Joints arthritis was induced by injection of Monosodium Iodoacetate (1 ml is injected into each knee). **Results** revealed that the tangerine and apricot ice cream enriched with turmeric and bee pollen had the highest levels of protein, fat and ash compared to the rest of the treatments. The results also showed that all bee pollen treatments reduced serum ROS and MDA, while apricot ice cream treatment were more effective than tangerine ice-cream for ROS and MDA reducing. All bee pollen treatments elevated levels of antioxidant enzymes (GSH, SOD and Catalase), however the most effective treatments was Bee pollen with Bee

honey and turmeric, followed by Apricot turmeric bee pollen ice cream. **In Conclusion**, the combination of fruit ice cream, turmeric and bee pollen yielded an acceptable sensory product and demonstrated protective actions for MIA-induced arthritis in rats.

The study recommends: the need to rely on turmeric and bee pollen in the mentioned proportions, to increase the nutritional value and functional properties of food products, and prevent arthritis.

Key words: bee pollen, turmeric, tangerine, apricot, ice cream, bee honey, olive oil, arthritis and MIA.

INTRODUCTION

Afsar, (2011) Inflammation is an essential survival during tissue injury and infection occurs as a result of the response of the immune system and its ability to respond to injury. Inflammatory responses are essential to maintain the normal balance of the affected body tissues. Specific molecular patterns associated with tissue injury or infections are recognized by inflammatory responses. The inflammatory process is mediated by key regulators that clarify proinflammatory molecules. Infections are often associated with very harmful side effects on the patient's health. While changes in inflammatory responses are caused by genetic variations or persistent inducers are on the rise, causing a variety of pathophysiological conditions and inflammatory diseases.

There are properties associated with naturally occurring bioactive compounds that have had a major therapeutic effect. Flavonoids are among the potential effects. Flavones are the flavonoids found in citrus fruits in the world. **(Ye 2017)**.

Apricot fruit is rich in lycopene, which is a key factor in preventing cancer and lowering cholesterol, thus preventing cardiovascular disease. Some apricot cultivars have been evaluated for their antioxidant content, which indicates their beneficial effect on health in the human diet **(Leccese et al., 2010)**. It is indicated results showed that antioxidants, such as vitamin C, polyphenols and carotenoids are found in a high percentage of apricots **(Fратиanni et al., 2018)**.

Katarzyna et al., (2015) reported that bee pollen has an important therapeutic effect; they are valued as natural remedies because they have medicinal and nutritional effects. The procedures that were performed on pollen show that it contains antifungal, antimicrobial, antiviral, and anti-inflammatory, as well as being an effective topical analgesic. Where the effective properties of bee pollen and its ability to use in various pathological conditions were revealed through the available mechanisms, through which bee pollen affects the healing process of wounds and burns.

Matthew et al., (2017) stated that turmeric is an important anti-inflammatory agent that has been used for many years to treat disease conditions. Pharmacological and experimental trials showed its effect as an anti-inflammatory agent. It has been proven that turmeric has an effective effect in the treatment of chronic diseases, the most important of which are inflammatory bowel disease, rheumatoid arthritis, Alzheimer's and common malignancies that affect cancer of the stomach, colon, lung, skin and breast.

Ice cream contains tissues to form the structure of fat and fat is an important characteristic for multiple properties. The results showed that the properties are a source of hardness, ideal shape and physical properties. The fats contain high quality aspects. They give the cream a smooth texture and a distinctive flavor. a good carrier for added flavor substances and a good synergist, the major responsible for the creamy texture, helps in foam stabilization, provides the ice cream structure, donates good melting aspects, helps in lubrication of the freezer barrel while ice cream freezing **Goff et al., (2006)**.

MATERIALS AND METHODS

A – Materials

Plant materials: Bees' pollen, bee honey, was collected on May 2016 from an experimental apiary located in Mansoura, Dakhalia. Ice cream ingredients (turmeric, tangerine, apricot, and olive oil ice were purchased from local market, Mansoura Egypt.

Chemical materials: Monosodium idoacetate (MIA) powder was purchased commercially from Sigma-Aldrich Corporation (American Chemicals Company).

B- Methods

Preparation of fruit Ice cream enriched with turmeric and bee pollen

Fruit juice was prepared from fresh fruits (tangerine and apricot) Ice cream was made by adding tangerine or apricot juices (70%) to coconut milk (19%) and bee honey (10%) thin mixing them together, then adding a (1%) ice cream stabilizer and beating them with electric beaters until smooth and then placed in the freezer. Fruit turmeric ice cream was prepared by the addition of 1.5% turmeric, and fruit turmeric bee pollen ice cream was prepared by the addition of 1.5% turmeric and 7%bee pollen. All ice cream samples were frozen at -18°C .

Sensory evaluation

Sensory evaluation according to **Ohmes *et al.*, (1998)** was used to evaluate fruit ice cream fortified with turmeric and pollen. Fifteen (15) participants from the Department of Food Sciences, National Research Center, Egypt were recruited for the study. A nine-point pleasure scale ranging from 1 to 9 was used for the study. On the pleasure scale, 9 are represented as very acceptable, and 1 is represented as not at all acceptable.

Experimental animals

This study was carried out on seventy adult male Sprague Dawley rats weighing $230\text{ gm} \pm 10\text{gm}$. Rats were obtained from the Medical Experimental Research Center, Faculty of Medicine, Mansoura University and divided into ten equal groups. Rats were housed under standard conditions (12 h. light – dark cycles, 8 rats per 1500 cm^2 cage in $22 \pm 3^{\circ}\text{C}$) for one week to acclimate before experimental study, during this period, rats were feed on standard rat diet (Casein 200, Corn starch 497, Sucrose 100, Mineral mixture100, Vitamin admixtures 20, Corn oil 50, Cellulose 30 and DL-methionine 3 g/kg diet) according to **Lane-peter and Pearson (1971)**.

Chemical determinations:

Chemical composition of fruit Ice cream samples:

The content of moisture, total lipids and Crude protein was carried out according to the methods of **A.O.A.C (2005)** Carbohydrate content was calculated by **Pearson (1973)** as follows: %Carbohydrate =100- (% moisture+% protein +% fat +% ash).

Experimental design

This experiment was designated to study the protective effect of six bee pollen treatments on rats infected with MIA diet. Seventy rats were classified into the following groups:

- Group 1: (control negative) rats were fed on basal diet only.
- Group 2: (control positive) rats were fed on basal diet in addition to 1% MIA:
- Group 3: Rats were fed on basal diet+1% MIA+ 1ml bee pollen.
- Group 4: Rats were fed on basal diet+1% MIA+ 1ml tangerine turmeric ice- cream.
- Group 5: Rats were fed on basal diet+ 1% MIA+1ml tangerine turmeric bee pollen ice-cream.
- Group 6: Rats: were fed on basal diet+1% MIA+1ml apricot turmeric ice- cream.
- Group 7: Rats: were fed on basal diet+1% MIA+1ml apricot turmeric bee pollen ice-cream.
- Group 8: Rats: were fed on basal diet +1% MIA+ bee pollen+ olives oil (1:1).
- Group 9: Rats: were fed on basal diet +1% MIA+ bee pollen +bee honey (1:1).
- Group 10: Rats: were fed on basal diet +1% MIA+ bee pollen + bee honey+ turmeric (1:1:1).

The rats were subjected daily to the physical examination through observation of healthy conditions such as external appearance, activity of rats and body conditions.

Laboratory examination for blood samples and knee tissue

At the end of the experiment period, rats were anesthetized by diethyl ether. Blood samples were collected from the inner canthus of the rat's eye using heparinized capillary tubes, then the serum was obtained after centrifugation at 3000 rpm for 10 minutes. Samples were preserved in a deep freezer at -20°C until they were used for various biochemical analyses.

Collection and preparation of knee tissue samples for analysis

After the animals were killed, the articular capsule of the right knee joint was taken as specimens from each rat in all eleven groups. The articular capsule of the right knee joints were anatomized, frozen by liquid nitrogen and pulverized in a mortar and pestle, then solubilized in 4 ml of BPS (phosphate buffer saline, pH=7) in order to obtain homogeneous tissue.

Estimation of oxidative stress and lipid peroxidation parameters in tissue

The homogeneous knee tissue was centrifuged at 10000 rpm for 10 minutes depending on the method of **Lemos, et al., (2009)**, and the supernatants were used to discover the existence of the measurement of level of malondialdehyde (MDA), (ROS), and antioxidant enzyme in knee tissue: superoxide dismutase (SOD), catalase (CAT), and glutathione reduced (GSH) were estimated according to **Mistura and Midora (1987)**; **Nandi and Chatterje (1988)**; **Claiborne (1985)** and **Gross et al., (1967)** respectively.

Calcium ion binds to o-cresolphthalein and forms a chromogenic complex which can be detected calorimetrically and vitamin D according to **Daniel (1952)**. 25-hydroxy vitamin D was assayed using Elisa kits: MYBiosource, USA and Rat Calcitonin (Elisa kits): MYBiosource, USA. The enzymes activity in liver, kidney and heart homogenates were assayed using commercially available assay kits. Reduced glutathione (GSH): Bio-diagnostic (diagnostic and research reagents), Giza, Egypt;

Superoxide dismutase (SOD): Bio-diagnostic (diagnostic and research reagents) and Catalase (CAT): Bio-diagnostic (diagnostic and research reagents), Giza, Egypt. The Malondialdehyde (MDA): Bio-diagnostic (diagnostic and research reagents), Giza, Egypt. Levels of liver, kidney and heart samples were determined using a (colorimetric method) Giza, Egypt.

CBT was measured using TKA . surgery **Khatib, (2015)** Bio-diagnostic (diagnostic and research reagents), Giza, Egypt, Trabecular bone tissue analysis (TBTA) involves examination of the vertical and horizontal trabeculae of the pre-identified bone region(TBD) **Woloszynski, (2012)**. Bio-diagnostic (diagnostic and research reagents), Giza, Egypt

Histopathological analysis on knee joint specimens:

Decalcification processes of knee joints was achieved by using the chelating agent EDTA disodium salt (10%) solution (5.5g EDTA in 90ml distilled water and 10ml formaldehyde, 37:40%), because it binds with or absorb the calcium ions; where it work slowly but preserves all cellular components.

The knee joint tissue was submerged in EDTA solution, and solution was changed daily for about four weeks until softening of specimens was achieved, and that time varies depending on tissue size band species.

For histopathological examination using the light microscope specimens were processed to form paraffin blocks, paraffin wax tissue blocks were prepared by cutting them into slices of 4 micron thickness. The obtained tissue slices were collected on glass slides, and subjected was deparaffinized and stained by Hematoxylin and eosin stain **Bancroft et al., (2012)**.

Statistical analysis:

All obtained data were statistically analyzed by SPSS computer software according to EL Said (1978). The calculation accrued by analysis of Variance ANOVA and follow up LSD (SPSS) Computer program variation.

RESULTS AND DISSCUSION

1. Effect of the addition of turmeric and bee pollen on chemical composition of tangerine ice-cream:

Chemical composition of tangerine turmeric bee pollen ice-cream is presented in Table 1. The highest moisture content was for tangerine ice-cream (77.63 ± 7.01 g/100g) followed by tangerine ice cream with turmeric (63.14 ± 3.03 g/100g); however the lowest content was recorded for tangerine turmeric bee pollen ice-cream (61.05 ± 5.02 /100g). Protein content varied from 1.49 ± 0.35 g/100g for tangerine ice cream to be 6.10 ± 0.5 g/100g for tangerine ice turmeric bee pollen ice-ream. Data show that fats content in tangerine ice-cream was 3.08 ± 0.74 g/100g; however the highest fat content was recorded as 6.84 ± 0.8 g/100g in tangerine turmeric bee pollen ice-cream.

On the other hand ash content ranged between 0.68 ± 0.31 and 4.15 ± 1.52 g/100g in tangerine ice cream and tangerine turmeric bee pollen ice-cream respectively. on the other hand fiber content recorded the lowest value (1.93 ± 0.35 g/100g)in tangerine ice-cream; followed by tangerine turmeric bee pollen ice-cream (8.79 ± 0.71 g/100g) and tangerine turmeric ice-cream (9.08 ± 0.86 g/100g). The highest carbohydrates content was for tangerine turmeric ice-cream (24.90 ± 3.02 g/100g), moreover the lowest carbohydrates content was in tangerine ice-cream (17.12 ± 2.01 g/100g). It can be noticed that increased saturated fat content, mono U.S.F and poly U.S.F in tangerine turmeric bee pollen ice-cream, followed by tangerine turmeric ice-cream and tangerine ice-cream respectively.

Generally, no significant differences between all rats group in experimental were noticed.

The results in this study are similar to that obtained by **Goff, (2008)** recorded that adding tangerines to ice cream increased the carbohydrate content and the use of turmeric also improved the chemical properties of ice cream, and this is in agreement with **Sacchetti et al., (2005)** who reported that bee pollen contains fats, proteins, vitamins (including B-complex and folic acid) and minerals. It contains all the

essential amino acids needed by the human body. Besides, it also contains biologically active compounds, as well as flavonoids, which are products produced by the metabolism of plants and which contain many phenolic compounds, which have antioxidant and anti-inflammatory activity which improves the chemical properties of the ice cream product and this is indicated by both *Feás et al., (2012)* and *Medeiros et al., (2008)*.

Table 1: Chemical composition of tangerine ice-cream, tangerine turmeric ice-cream and tangerine turmeric bee pollen ice-cream:

Sample	Moisture (g/100g)	Protein (g/100g)	Fats(g/100g)				Ash (g/100g)	Fiber (g/100g)	Carbohydrates (g/100g)
			S	M	P				
Tangerine ice-cream	77.63 ±7.01	1.49 ±0.35	3.08 ±0.74	1.29 ±0.24	0.93 ±0.52	0.60 ±0.010	0.68 ±0.31	1.93 ±0.35	17.12 ±2.01
Tangerine turmeric ice- cream	63.14** ±3.03	3.62 *** ±0.6	5.53 *** ±0.5	2.06** ±0.25	1.27 ±0.25	1.33 *** ±0.30	2.81*** ±0.5	9.08* ** ±0.8	24.90** ±3.02
Tangerine turmeric bee pollen ice- cream	61.05** ±5.02	6.10* ** ±0.5	6.84* ** ±0.8	2.52** ±0.51	1.94* * ±0.47	2.06* ** ±0.07	4.15* ** ±1.52	8.79* ** ±0.71	23.83** ±1.98

T: total fat, S: saturated fat, M: mono saturated fat, P: poly saturated fat

2. Effect of the addition of turmeric and bee pollen on sensory aspects of tangerine ice-cream:

Scores of sensory evaluation expressed as taste, odor, color, appearance and overall acceptability of tangerine ice-cream, tangerine ice-cream with turmeric, tangerine turmeric ice-cream bee pollen are presented in Table 2. The preferred taste score was recorded for tangerine ice cream (9±0.51), followed by tangerine turmeric ice-cream; however the lowest scores were for tangerine turmeric bee pollen ice-cream. Results show insignificant differences in odor between all samples. Moreover, the

highest scores in treatments were for tangerine ice cream (8.52 ± 0.25) and the lowest was for tangerine turmeric bee pollen ice-cream (8 ± 0.86). The best color was for tangerine ice-cream (9.51 ± 0.55) however it slightly decreased by the additions in tangerine turmeric ice-cream and tangerine turmeric bee pollen ice-cream. Data show that the addition decreased appearance scores from 9 ± 0.24 in tangerine ice cream to be 8 ± 0.20 and 7 ± 0.30 in tangerine ice cream turmeric ice-cream and tangerine turmeric bee pollen ice-cream. Overall acceptability scores recorded the highest value for tangerine ice-cream (9.51 ± 0.21) followed by tangerine turmeric ice-cream (9 ± 0.21) and tangerine turmeric bee pollen ice-cream. Finally, tangerine ice cream recorded the preferred sample in taste, odor, appearance and overall acceptability and slight decrease was observed by the additives of turmeric and turmeric with bee pollen.

These results are agree with **Anna et al., (2022)** recorded that adding of turmeric powder and paste significantly reduced the fat oxidation processes in the duck meat burger. Although the processes of lipid oxidation are accelerated, the coloring is lighter in cooled products. These additives were considered acceptable during the sensory evaluation. The most desirable flavor and taste, including its juiciness, while burgers with turmeric powder additives were rated higher for their desirable aroma and intensity. Published studies demonstrated how the use of bee pollen improved the profiles of volatile and sensory compounds of white wine **Amores et al., (2018)** which is in agreement with the research results.

Table 2: Sensory evaluation scores of tangerine turmeric bee pollen ice-cream:

Samples	Taste	Color	Odor	texture	Appearance	Over all acceptability
Tangerine ice-cream	51.9 ± 0	9.51 ± 0.55	8.52 ± 0.25	9.54 ± 0.21	9 ± 0.24	9.51 ± 0.21
Tangerine turmeric ice-cream	8 ± 0.65	9 ± 0.45	8 ± 0.86	8.53 ± 0.54	8^* ± 0.20	9 ± 0.21
Tangerine turmeric bee pollen ice-cream	7.5^* ± 0.55	8^* ± 0.21	8.5 ± 0.54	8^* ± 0.24	7^{**} ± 0.30	8.5^* ± 0.12

3. Effect of the addition of turmeric and bee pollen on chemical composition of apricot ice-cream:

Chemical composition of apricot turmeric bee pollen ice-cream is presented in Table 3. The highest moisture content was for apricot ice-cream (78.12 ± 2.89 g/100g), followed by apricot turmeric ice-cream (71.95 ± 3.95 g/100g); however the lowest content was recorded for apricot turmeric bee pollen ice-cream (71.39 ± 2.21 g/100g). Protein content varied from 3.08 ± 1.01 g/100g for apricot ice-cream to 6.15 ± 1.12 g/100g for apricot turmeric bee pollen ice-cream. Data show that fats content in apricot ice-cream was 3.65 ± 0.25 g/100g; however the highest fat content was 6.84 ± 1.9 g/100g in apricot turmeric bee pollen ice-cream. On the other hand fiber decreased from 1.86 ± 0.05 g/100g in apricot ice-cream to be 2.12 ± 0.26 and 7.30 ± 1.02 g/100g in apricot turmeric ice-cream and apricot turmeric bee pollen ice-cream respectively. The highest carbohydrates content was in apricot turmeric ice-cream (14.37 ± 1.02 g/100g); moreover the lowest carbohydrates content was in apricot ice- turmeric bee pollen ice-cream (11.24 ± 0.92 g/100g). It can be noticed an increased content of saturated fat, mono U.S.F and poly U.S.F with the addition of turmeric and turmeric with bee pollen.

The results are in parallel with those obtained by **Laith (2019)** recorded that the effect of turmeric powder on the chemical and microbiological composition of soft cheese. Different concentrations of turmeric powder (0, 0.1, 0.2 and 0.3%) represented (T1, T2, T3, T4) were added to the processed milk to the soft cheese. The results showed that there were no significant differences between the cheese of the different treatments (T2, T3, and T4).and comparison cheese (T1) for moisture, protein, fat and ash. **Oktay Yerlikaya (2014)** studied the effect of bee pollen supplementation on the organoleptic, antimicrobial, chemical, rheological and biomechanical properties of fermented milk drinks was studied. It was bee pollen Added at a rate of 2.5 mg mL⁻¹ (B), 5 mg mL⁻¹ up to 7.5 mg/mL⁻¹ added pollen, bee pollen supplementation has shown improvement with increasing pollen concentration which has not resulted in any negative effect on physical and chemical properties .

Table 3: Chemical composition of apricot ice-cream, apricot turmeric ice-cream and apricot turmeric bee pollen ice-cream:

Sample	Moisture (g/100g)	Protein (g/100g)	Fats(g/100g)			Ash (g/100g)	Fiber (g/100g)	Carbohydrates (g/100g)
			S	M	P			
Apricot ice-cream	78.12±	3.08±	3.65±	0.81±	1.49±	1.13±	1.08±	14.13±1.21
	2.89	1.01	0.25	0.04	0.35	0.76	0.02	
Apricot turmeric ice-cream	71.95*	4.79*	5.87*	1.42	2.06	1.98	3.02*	14.37*
	±3.95	±1.25	±0.62	±0.36	±0.85	±0.95	±0.56	±1.02
Apricot turmeric bee pollen ice-cream	71.39*	6.15**	6.84**	1.97**	2.31*	2.43*	4.38**	11.24*
	±2.21	±1.12	±1.9	±0.29	±0.85	±1.01	±0.98	±0.92

T: total fat, S: saturated fat, M: mono saturated fat, P: poly saturated fat

4. Effect of the addition of turmeric and bee pollen sensory aspects of apricot ice-cream:

Scores of sensory evaluation expressed as taste, odor, color, appearance and overall acceptability of apricot ice-cream, apricot turmeric ice-cream and apricot turmeric bee pollen ice-cream are represented in Table 4. The preferred taste scores was recorded for apricot ice-cream (9.5 ± 0.52), followed by apricot turmeric ice-cream; however the lowest scores was for apricot turmeric bee pollen ice-cream (8 ± 0.12) with insignificant differences. The best color was for apricot ice-cream (9.5 ± 0.58), followed by apricot turmeric ice-cream and apricot turmeric bee pollen ice-cream. Data in the same table show that the addition of turmeric or turmeric with bee pollen decreased appearance score from 9.9 ± 0.21 to be 8.5 ± 0.01 for turmeric bee pollen ice-cream. The highest texture score was recorded (9.9 ± 0.21) for apricot ice-cream; however it was lower to be to 9.5 ± 0.50 in apricot turmeric ice-cream. Overall acceptability scores recorded the highest value for apricot ice-cream (9.9 ± 0.21) followed by apricot turmeric ice-cream (9.8 ± 0.20) and apricot turmeric bee pollen ice-cream (9.5 ± 0.41). Finally, apricot ice-cream with turmeric or turmeric with bee pollen recorded the acceptable sensory in taste, odor, appearance and the differences overall acceptability were insignificant.

These results are confirmed with **Park et al., (2012)** recorded that the effects of addition of turmeric powder (0%, 2%, 4%, 6% and 8%) were examined in order to obtain an antioxidant-enriched cake with good physic-chemical and sensorial properties. The rheological properties of doughs were **evaluated** using dynamic rheological measurements. Addition of turmeric powder up to 8% caused significant changes on dough characteristics and on cake rheological properties. This is consistent with the results obtained. **Laith (2019)** recorded that the effect of turmeric powder on the sensory evaluation of cheese showed no significant differences between cheese treated with turmeric powder (T2, T3, T4) and control sample (T1) for color, texture and bitterness. Regarding flavor, the results showed that there was a significant difference between the cheese samples treated with 0.3% (w/v) turmeric powder (T4) and the untreated (comparator) cheese sample (T4). The PV and AV results recorded that cheese processed with different concentrations of turmeric powder was lower ($p > 0.05$) than unprocessed cheese.

Table 4: Sensory evaluation scores of apricot ice-cream, apricot turmeric ice-cream and apricot turmeric bee pollen ice-cream:

Samples	Taste	Color	Odor	texture	Appearance	Over all acceptability
Apricot ice-cream	9.5±0.52	9.5±0.58	9.9±0.21	9.9±0.21	9.9±0.21	9.9±0.21
Apricot turmeric ice-cream	9 ±0.65	8.5 ±0.21	9* ±0.21	9.5 ±0.50	9* ±0.21	9.8 ±0.20
Apricot turmeric bee pollen ice-cream	8 ±0.12	8* ±0.23	8** ±0.41	9 ±0.21	8.5** ±0.01	9.5 ±0.41

5. Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on serum ROS and MDA:

Knee ROS and MDA in serum shown in Table 5. The results showed an improvement in serum ROS rate compared with the positive group, where the best value for improvement was recorded in group received bee pollen with bee honey and turmeric followed by group of apricot turmeric bee pollen ice-cream, tangerine turmeric bee pollen ice-

cream, bee pollen with bee honey, bee pollen with olive oil, bee pollen, apricot turmeric ice-cream and tangerine turmeric ice-cream from 28.93 ± 2.35 , 31.31 ± 3.36 , 36.46 ± 3.32 , 37.91 ± 3.03 , 37.81 ± 5.33 , 43.23 ± 6.46 , 43.94 ± 4.78 and 45.63 ± 4.15 respectively.

Results obtained demonstrated the effect of the treatments fed to the rats on the level of MDA in the serum, where it had the lowest level in the apricot turmeric bee pollen ice-cream group from 6.86 ± 0.29 , followed by the group fed on bee pollen with bee honey and turmeric. On the other hand, the results showed a difference in the other groups compared with the infected group, where the highest level was in the group fed on bee pollen from 18.91 ± 0.91 , followed by the rest of the other treatments from 17.39 ± 1.79 , 15.17 ± 1.70 , 15.04 ± 1.73 and 11.94 ± 1.61 in tangerine turmeric ice-cream, bee pollen with bee honey, bee pollen with olive oil and apricot turmeric ice-cream respectively.

These data are in accordance with **Prabhakar et al., (2020)** evaluated the potential protective effects of curcumin against mercury chloride (HgCl₂)-induced oxidative stress in rats. In this study, male Wistar rats were oxidative stress-stressed with HgCl₂ (5 mg/kg body weight i.p.). One group of rats was simultaneously supplemented with curcumin (340 mg/kg body weight) to assess its protective ability against induced oxidative stress. Curcumin supplementation provided significant ($p < 0.05$) protection against HgCl₂-induced changes by improving ROS, PCO, and SA and -SH levels in erythrocyte membrane and plasma. Thus, curcumin protects against HgCl₂-induced oxidative stress. **Marzouk et al., (2007)** reported that bee pollen, naturally occurring antioxidant, as a powerful ROS scavenger in rats, they had been shown to have broad biological activities which are principally attributed to the presence of flavonoids (major component: Rutin, quercetin and galangin) and caffeic acid phenethyl ester (CAPE).

Table 5: ROS and MDA levels in rat serum as affected by administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen:

Variables Groups	Serum ROS	MDA (Nm/mg protein-ml) in serum
	Mean SD	Mean SD
Negative	23.1***±5.25	8.00***±1.04
Positive	47.6±2.85	20.4±2.23
Bee pollen	43.23±6.46	18.91±0.91
Tangerine turmeric ice-cream	45.63±4.15	17.39**±1.79
Tangerine turmeric bee pollen ice-cream	36.46***±3.32	9.16***±0.43
Apricot turmeric ice-cream	43.94±4.78	11.94***±1.61
Apricot turmeric bee pollen ice-cream	31.31***±3.36	*** 6.86±0.29
Bee pollen with olive oil	37.81*±5.33	15.04***±1.73
Bee pollen with bee honey	37.91*±3.03	15.17***±1.70
Bee pollen with bee honey and turmeric	28.93***±2.35	8.00***±0.55

Mean ± SD values in each column having different stars (*, **, ***) are significantly different at $P < 0.05$.

6. Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on levels of serum antioxidant enzymes:

GSH, SOD and catalase in serum are shown in Table 6. The results show a lower level of GSH in the positive group compared with the negative group. The best GSH level was in the groups fed on tangerine turmeric bee pollen ice-cream, bee pollen with bee honey and turmeric and apricot turmeric bee pollen ice-cream (31.23 ± 6.11 , 29.13 ± 2.84 and

27.23±2.28) respectively. On the other hand the results recorded a decreased in GSH in (17.79±1.44, 18.91±3.47) in group received bee pollen and tangerine turmeric ice-cream group respectively.

Results showed a higher level of serum SOD in group, administered with apricot turmeric bee pollen ice-cream, tangerine turmeric bee pollen ice-cream, and bee pollen with bee honey and turmeric (162.2±7.42, 162.2±7.42 and 148.47±12.03 respectively) compared to the positive group. However results showed the lowest level of SOD in group received bee pollen (79.97±1.16).

Data shows that improved levels of serum catalase levels in all treatments compared to the positive group. The levels of apricot turmeric bee pollen ice-cream, tangerine turmeric bee pollen ice-cream and bee pollen with bee honey and turmeric were 38.84±4.78, 35.51±5.86 and 35.19 ±2.02 respectively.

These data are in accordance with **Linskens and Jorde (1997)** recognized bee pollen as a medicine, because it contains bioactive components, which enhance health through the interactions of food matrix and nutrients in maintaining human biological processes such as proteins, namely C, E, β carotene, B-complex), trace elements and polyphenols (**Malerbo-Souza, 2011**). The main bioactive components of bee pollen are the polyphenols, mostly flavonoids. Polyphenols possess diverse biological properties such as antiaging, ant carcinogen, antioxidant, anti-inflammatory, cardio protective and ant atherosclerosis, so the interest in the importance of ant atherosclerosis, **Han et al., (2007)**. Antioxidant activity was determined using a spectrophotometer and no negative effects were shown on glutathione (GSH) and superoxide dismutase (SOD) due to pollen dependence **Kaur et al., (2014)**.

Gökhan et al., (2008) found that carbaryl was determined to cause negative changes in most of the oxidative stress markers SOD and CAT investigated, these effects were observed to alleviate with the administration of bee pollen

Table 6: Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on levels of serum antioxidant enzymes:

Variables Groups	GSH (Nm/mg protein-ml) in serum	SOD (activity% inhibition/mg protein-ml)in serum	Catalase (u/mg protein-ml) in serum
	Mean SD	Mean SD	Mean SD
Negative	29.83***±0.27	195.5***±17.95	49.94***±8.37
Positive	17.59±1.34	68.7±6.66	22.66±3.00
Bee pollen	17.79±1.44	79.97±1.16	26.61±4.31
Tangerine turmeric ice-cream	18.91±3.47	93.51***±7.15	29.47±3.96
Tangerine turmeric bee pollen ice-cream	31.23***±6.11	149.71***±13.93	35.51***±5.86
Apricot turmeric ice-cream	22.94**±2.61	92.43***±6.20	30.07*±2.49
Apricot turmeric bee pollen ice-cream	27.23***±2.28	162.2***±7.42	38.84***±4.78
Bee pollen with olive oil	19.96±0.20	90.49***±7.56	25.83±2.88
Bee pollen with bee honey	20±2.34	79.57±13.47	28.33±4.08
Bee pollen with bee honey and turmeric	29.13***±2.84	148.47***±12.03	35.19***±2.02

Mean ± SD values in each column having different starts (*, **, ***) are significantly different at $P < 0.05$.

7. Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on levels of Liver, Kidney and Heart tissues antioxidant enzymes:

MDA and antioxidant enzymes in liver (nM/mg protein-ml) are shown in Table7. Results show that the lowest level of MDA was in the turmeric bee pollen with bee honey and turmeric (3.91±0.38), while the highest level in treatment was for the group fed only bee pollen

(9.77 ± 1.20). However MDA in kidney increased in group treated with turmeric tangerine ice-cream (5.76 ± 0.36), while MDA decreased in group received turmeric tangerine bee pollen ice-cream. On the other hand it was the highest level of MDA in heart for the group fed bee pollen (5.6 ± 0.70) and the lowest level was in the group of turmeric tangerine bee pollen ice-cream.

Apricot turmeric bee pollen ice-cream was the strongest treatment for GSH elevation in liver tissue (5.03 ± 0.54), while the best level of GSH in kidney was in tangerine turmeric ice-cream group (4.47 ± 0.10); however apricot turmeric bee pollen ice-cream group recorded the best GSH level in heart (3.36 ± 0.45).

On the other hand apricot turmeric bee pollen ice-cream was the strongest treatment for evaluating liver tissue SOD from 24.44 ± 2.23 , while the best level of SOD in kidney was in apricot turmeric bee pollen ice-cream group (8.29 ± 0.72); however bee pollen with bee honey and turmeric group recorded the best SOD level heart (8.56 ± 0.97).

Tangerine turmeric bee pollen ice-cream was the strongest treatment for elevating of liver tissue catalase from 3.99 ± 0.19 in positive control to be 5.23 ± 0.21 , while the best level of catalase in kidney was in bee pollen with bee honey and turmeric group (3.36 ± 0.19); however bee pollen with bee honey and turmeric group recorded the best Catalase level in heart (3.56 ± 0.40).

These results are confirmed with **Banach *et al.*, (2014)** who reported that turmeric can increase the activity of antioxidants in the blood such as superoxide dismutase (SOD). A recent systematic review and meta-analysis of randomized control data related to efficacy Supplementation with purified turmeric on oxidative stress parameters - indicated significant the effect of turmeric on all oxidative stress parameters examined including Plasma activities of SOD and catalase, as well as serum glutathione peroxidase concentrations (GSH) and lipid peroxides **Sahebkar *et al.*, (2015)**.

Research has shown that honey improves wound healing through the antioxidant response by activating AMPK (5'-adenosine protein kinase monophosphate) and antioxidant enzymes that relieve oxidative stress. It improves the level of enzymatic and non-enzymatic antioxidants, which include the enzymatic antioxidant superoxide dismutase (SOD), catalase (CAT) and glutathione (GSH) **Erejuwa et al., (2012)**. In rats treated with bee pollen (BP), the MDA levels in the liver and kidney were significantly lowered compared to the groups treated with CCl₄ or CP alone **Yildiz et al., (2013)**. The GSH-Px levels in the liver, kidney, heart and brain were significantly higher in rats administered with propoxour and bee pollen (BP) than those administered propoxour only **Eraslan et al., (2009)**.

Marzouk et al., (2007) reported a significant decrease in the plasma and tissue (liver, kidney and brain) MDA level after administration Bee pollen being an anti-lipoperoxidant agent, inhibits formation of lipid peroxides **Eraslan et al., (2008)**, it acts by lowering the lipid peroxidation. Scavenging free radicals and its activity is attributed to its structure, the study on the bioflavonoid of bee pollen showed it decreased MDA levels and increased antioxidant enzyme levels in cardiac ischemia reperfusion injury

Table 7: Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on levels of Liver, Kidney and Heart tissues antioxidant enzymes:

	Antioxidant markers	G1 Negative	G2 Positive	G3 BP	G4 T.T.IC	G5 T.T.BP.IC	G6 A.T.I.C	G7 A.T.B.P.IC	G8 BP+OO 1:1	G9 BP+BH 1:1	G10 BP+BH+T 1:1:1:1
Liver	MDA	2.93*** ±0.74	10.1±0.66	9.77±1.20	9.26±0.51	4.01***±0.48	7.11*** ±0.93	4.1*** ±0.24	7.1*** ±0.24	7.9*** ±0.50	3.91*** ±0.38
	GSH	6.09*** ±0.67	3.04±0.67	3.27±0.22	3.66±0.10	4.9*** ±0.50	3.54±0.15	5.03** ±0.54	3.44*** ±0.28	3.61*** ±0.0.30	4.99*** ±0.41
	SOD	30.19*** ±0.58	10.33±0.96	11.37±1.38	11.81±1.09	24.39*** ±1.80	12.74** ±0.76	24.44*** ±2.23	15.01*** ±1.22	11.49±0.70	23.61*** ±1.39
	Catalase	7.07*** ±0.06	3.99±0.19	4.26±0.26	4.37±0.21	5.23*** ±0.21	4.63±0.16	4.69±0.27	4.1±0.44	4.94±0.22	4.97** ±0.97
Kidney	MDA	1.91*** ±0.28	6.33±0.27	5.3*** ±0.35	5.76** ±0.36	2.01** ±0.19	4.36*** ±0.35	2.31*** ±0.07	4.43*** ±0.35	4.64*** ±0.22	2.07** ±0.10
	GSH	4.31*** ±0.35	2.07±0.05	2.34±0.08	4.47* ±0.10	3.56*** ±0.29	2.59** ±0.25	3.54*** ±0.28	2.57** ±0.18	2.46±0.13	3.56*** ±0.32
	SOD	9.63*** ±1.94	3.97±0.29	3.59±0.19	4.27±0.34	7.81*** ±0.72	4.11±0.33	8.29*** ±0.72	4.63±0.26	3.84±0.14	7.77*** ±0.42
	Catalase	4.21*** ±0.25	2.33±0.14	2.64±0.35	2.71±0.22	2.94±0.28	2.77*** ±0.14	2.64** ±0.25	2.74*±0.15	2.57±0.21	3.36*** ±0.19
Heart	MDA	2.49*** ±0.20	5.67±0.37	5.6±0.70	4.9** ±0.35	1.9*** ±0.24	3.94*** ±0.13	1.99*** ±0.11	4.04*** ±0.22	4.2*** ±0.41	2.09*** ±0.09
	GSH	3.97*** ±0.21	2±0.10	2.33±0.11	2.3±0.08	3.19*** ±0.25	2.57* ±0.14	3.36** ±0.45	2.17±0.08	2.23±0.27	3.24*** ±0.15
	SOD	14.5*** ±5.75	5.7±0.36	4.67±0.29	5.87±0.35	8±0.61	5.99±0.14	7.29±0.30	6.43±0.16	4.94±0.44	8.56*** ±0.97
	Catalase	4.16*** ±0.55	2.13±0.22	2.51±0.19	2.33±0.17	3.03*** ±0.29	2.63* ±0.18	3.06±0.13	2.7** ±0.29	2.7** ±0.11	3.56*** ±0.40

Mean ± SD values in each column having different starts (*, **, ***) are significantly different at P < 0.05.

(BP) bee pollen, (T.T.IC) tangerine turmeric ice-cream, (T.T.BP.IC) tangerine turmeric bee pollen ice-cream, (A.T.IC) apricot turmeric ice-cream,(A.T.BP.IC) apricot turmeric bee pollen ice-cream,(OO) olive oil,(BH) bee honey and (T) turmeric.

8. Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on levels of serum calcium, Vitamin D and Calcitonin:

Serum calcium, Vitamin D and Calcitonin levels are shown in Table 8. The results showed an improvement in serum calcium level compared with the positive group, where the highest value for improvement was recorded for apricot turmeric bee pollen ice-cream group followed by tangerine turmeric bee pollen ice-cream from 9.16 ± 0.95 , 8.97 ± 0.84 , and 8.94 ± 1.18 respectively. Data show a decrease in the content of V. D observed in the group fed pollen with bee honey (41.76 ± 4.32). On the other hand, Vitamin D content increased in the group treated with bee pollen with olive oil followed by apricot turmeric ice-cream group from 48.13 ± 3.10 and 45.84 ± 6.25 respectively.

Results showed increase in calcitonin content in the group of bee pollen with bee honey and turmeric, bee pollen with bee honey and bee pollen with olive oil from 4.34 ± 0.37 , 4.31 ± 0.41 and 4.01 ± 0.25 respectively. On the other hand, the calcitonin content decreased in both the apricot pollen ice cream group and the turmeric ice cream group, and the apricot and turmeric ice cream group (3.5 ± 0.17 and 3.59 ± 0.34) respectively.

These data are in accordance with **Olaitan et al., (2007)** indicated that honey led to an improvement in the level of calcium in the blood, and this is consistent with the results of the research. Feeding rat different treatments turmeric and fruits led to differences in serum VD and Calcitonin level which is in line with the findings of **Xiaoqi et al., (2018)**.

Table 8: Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on levels of serum calcium, Vitamin D and Calcitonin:

Variables Groups	Serum calcium (mg/dl)	Serum Vit D (ng/ml)	Serum Calcitonin (pg/ml)
	Mean SD	Mean SD	Mean SD
Negative	8.07** ±1.13	40.24 ±4.88	3.79*** ±0.13
Positive	7.87±0.28	45.7±3.48	3.76±0.22
Bee pollen	8.07±0.47	40.67±6.51	3.99±0.28
Tangerine turmeric ice-cream	8.94±1.18	44.96±6.62	3.97±0.13
Tangerine turmeric bee pollen ice-cream	8.97±0.84	44.93±4.82	3.87±0.62
Apricot turmeric ice-cream	8.46±0.86	45.84±6.25	3.59±0.34
Apricot turmeric bee pollen ice-cream	9.16±0.95	45.1±4.33	3.5±0.17
Bee pollen with olive oil	7.99±0.48	48.13±3.10	4.01±0.25
Bee Pollen with bee honey	7.97±0.51	41.76±4.32	4.31±0.41
Bee Pollen with bee honey and turmeric	8.73±0.78	44.1±2.73	4.34** ±0.37

Mean ± SD values in each column having different starts (*, **, ***) are significantly different at P < 0.05.

9. Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on levels of image analysis:

CBT, TBD and TB are shown in Table 9. The results showed a lower level of CBT in the positive group compared with the negative group. The best CBT level was in the groups fed on tangerine turmeric bee pollen ice-cream, tangerine turmeric ice-cream ,apricot turmeric ice-cream and apricot turmeric bee pollen ice-cream (192.41±23.73, 189.76±31.29,183.91±12.95and 170.61±13.77) respectively compared to positive control group. On the other hand results recorded a decreased levels in CBT (122.19±21.56 and 125.9±17.25) in group received bee pollen and bee pollen with olive oil group respectively.

Results showed a higher level of TBD in the group administered with tangerine turmeric bee pollen ice-cream, apricot turmeric ice-cream and tangerine turmeric ice-cream (67.96 ± 4.32 , 64.17 ± 4.32 and 62.86 ± 6.44 respectively) compared to the positive group. However the lowest level of TBT was in group received bee pollen with olive oil (46.76 ± 7.09).

Data shows improved levels of TB percent in all treatments compared to the positive group. The levels of tangerine turmeric bee pollen ice-cream, apricot turmeric ice-cream and tangerine turmeric ice- were 57.16 ± 3.45 , 55.39 ± 7.23 and 48.67 ± 3.90 respectively.

Feeding rat different treatments turmeric and fruits led to differences in the level of Image analysis which is in line with the findings of *Xiaoqi et al.*, (2018).

Table 9: Effect of daily administration of ice-cream with turmeric and bee pollen and mixes of honey, turmeric and bee pollen on levels of image analysis: المقصود بها كثافة العظم, التهابات الجسم و نسبة الاكتئاب

Variables Groups	Image analysis (CBT um)	Image analysis (TBD%)	Image analysis (TB area %)
	Mean SD	Mean SD	Mean SD
Negative	223.17*** ±9.27	78.39*** ±9.89	63.61*** ±6.66
Positive	110.2±9.96	48.26±2.65	46.06±3.77
Bee Pollen	122.19±21.56	56.83±4.63	44.76±3.37
Tangerine turmeric ice-cream	189.76*** ±31.29	62.86*** ±6.44	48.67±3.90
Tangerine turmeric bee pollen ice-cream	192.41** ±23.37	67.96*** ±4.32	57.16** ±3.45
Apricot turmeric ice-cream	183.91*** ±12.95	64.17*** ±4.32	55.39*** ±7.23
Apricot turmeric bee pollen ice-cream	170.61*** ±13.77	57.37±7.51	44.96±5.06
Bee Pollen with olive oil	125.9±17.25	46.76±7.09	48.04±4.48
Bee Pollen with bee honey	128.94±12.71	51.84±1.17	44.7±4.40
Bee Pollen with bee honey and turmeric 1:1:1	130.04±14.22	50.4±3.04	46.19±2.69

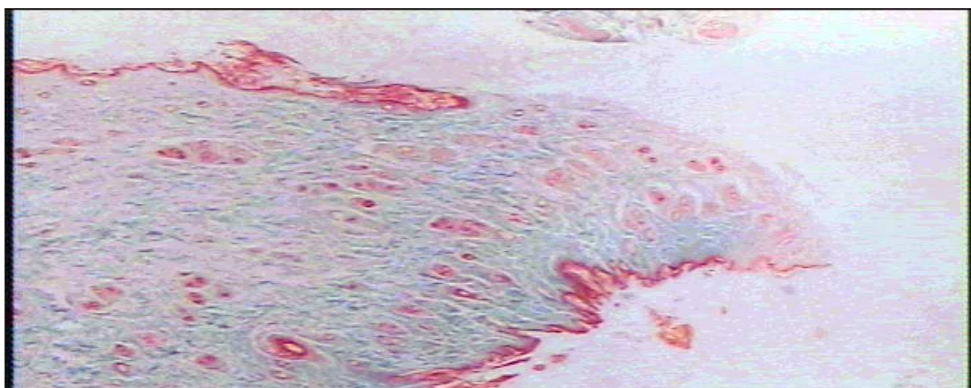
Mean ± SD values in each column having different starts (*, **, ***) are significantly different at $P < 0.05$.

Histopathological analysis of knee joint tissue specimens of arthritis rats:

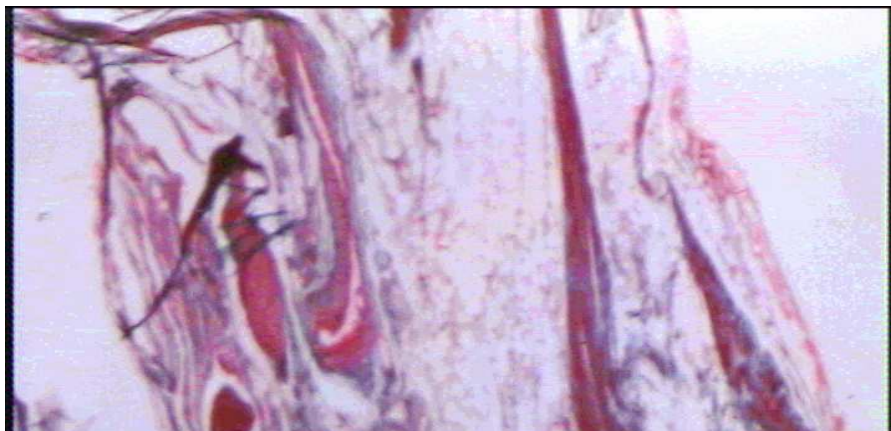
Isolated samples of knee joint tissues in the osteoarthritis treatment group that depended on bee pollen showed slight recovery of the knee joint with small necrosis in the cartilage surface and increased blood vessels in the subchondral bone as shown in picture(1).

Isolated samples of knee joint tissues in the osteoarthritis treatment group that depended on tangerine turmeric ice-cream showed slight recovery of the knee joint with small necrosis in the cartilage surface and increased blood vessels in the subchondral bone as shown in picture(2).

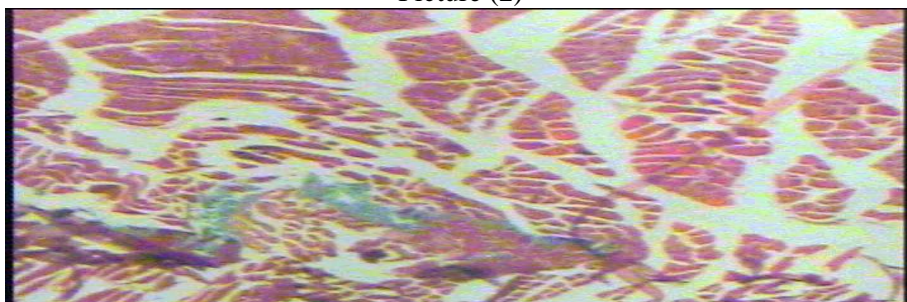
Isolated samples of knee joint tissues in the osteoarthritis treatment group that depended on apricot turmeric ice-cream showed slight recovery of the knee joint with small necrosis in the cartilage surface and increased blood vessels in the subchondral bone as shown in picture(3).



Picture (1)



Picture (2)



Picture (3)

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تأثير آيس كريم الفاكهة المدعم بالكركم وحبوب لقاح النحل على التهاب المفاصل المستحدث بواسطة ايودواسيتات أحادي الصوديوم في الفئران

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الملخص العربي:

العديد من الاضطرابات الصحية في الهيكل العظمي والعمود الفقري نتيجة الالتهاب الذي يصيب المفاصل، يرجع الي عدم اتباع نظام غذائي سليم. كما يمكن تقليل هذه الالتهابات عن طريق استخدام أغذية تقوية مثل الأعذية الغنية بمضادات الأكسدة والمعادن والفيتامينات كعوامل دفاعية. حيث تعتبر الفاكهة مصدر غني بالفيتامينات والمعادن. و لقد ثبت أن اليوسفي والمشمش لهما تأثير قوي مضاد للأكسدة. ويهدف هذا البحث الي دراسة تأثير آيس كريم المدعم بالفواكه (اليوسفي أو المشمش) والكركم وحبوب اللقاح على التهاب المفاصل الذي يسببه ايودواسيتات أحادي الصوديوم (يتم حقن 1 مل في كل ركبة). تم تحضير ست عينات من آيس كريم الفواكه على النحو التالي: (آيس كريم اليوسفي، آيس كريم اليوسفي مع الكركم، آيس كريم اليوسفي مع الكركم وحبوب اللقاح، آيس كريم مشمش، آيس كريم المشمش مع الكركم، آيس كريم المشمش مع الكركم وحبوب اللقاح) بالإضافة الي ثلاث عينات أخرى وهي حبوب اللقاح مع زيت الزيتون. حبوب اللقاح مع عسل النحل. وحبوب اللقاح مع عسل النحل والكركم. تم تقييم جميع المنتجات كيميائيا وحسبا وبيولوجيا. اظهرت نتائج التقييم الحسي ان اضافة الكركم وحبوب اللقاح اثري الخصائص الحسية للآيس كريم. اظهرت نتائج التقييم الكيميائي أن آيس كريم اليوسفي والمشمش المدعم بالكركم وحبوب اللقاح كان يحتوي على أعلى مستويات البروتين والدهون والرماد مقارنة ببقية المعاملات. و اظهرت نتائج التغذية علي المنتج في الفئران الي تحسن مستويات الكالسيوم في الدم و فيتامين د. و اظهرت النتائج أيضاً أن جميع معاملات حبوب اللقاح خفضت من مستوي جذور الاكسجين النشطه (ROS) و المألونداالدهيد (MDA)، بينما كانت معاملة آيس كريم المشمش أكثر فعالية من آيس كريم اليوسفي لتقليل ROS و MDA. جميع معاملات حبوب اللقاح زادت من مستويات الإنزيمات المضادة للأكسدة (SOD, GSH, Catalase)، وكانت أكثر المعاملات فعالية هي حبوب اللقاح مع عسل النحل والكركم يليها آيس كريم المشمش المدعم بالكركم وحبوب اللقاح. الخلاصة، أنتج الجمع بين آيس كريم الفاكهة والكركم وحبوب اللقاح منتجا حسيا مقبولا وأظهر تأثيرات وقائية لالتهاب المفاصل الناجم عن MIA في الفئران.

وتوصي الدراسة: بضرورة الاعتماد علي الكركم وحبوب اللقاح بالنسب المذكورة. لزيادة القيمة الغذائية والخواص الوظيفية للمنتجات الغذائية. وللوقاية من التهاب المفاصل.

الكلمات المفتاحية: حبوب اللقاح، الكركم، اليوسفي، المشمش، آيس كريم، عسل النحل، زيت الزيتون، التهاب المفاصل و ايودواسيتات أحادي الصوديوم.