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Cress Seed (*Lepidium sativum*) Role in the healthy Processed Spread Cheese and Its Anti-Diabetic Activity

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***Abstract*—** *The present study dealt with utilization of cress seeds (Lepidium sativum) in the manufacture of processed spread cheese, instead of emulsifying salt. Cress seed have also health promoting properties especially lowering glucose ratios. Cress seeds powder were prepared and added with the ingredients during manufacture of processed spread cheese at levels of six ratios (0.05, 1.5, 2.5, 3.5, 4.5 and 5.5%) compared with control (3% commercial emulsifying salt). The chemical, physical, microbiology and organoleptic properties of resultant samples were evaluated. Data revealed that processed spread cheese sample fortified with 3.5% cress seeds was the best either when fresh or during storage (8±2ºC for 3 months) and they had acceptable properties. Microstructure of processed cheese spread samples were also conducted. From nutritional view, processed cheese spread samples fortified with 3.5% cress seeds were used for feeding Adult male albino rats to study their effect on plasma glucose level. Obtained data indicated that the glucose level in plasma was significantly decreased (P<0.01) compared with the diabetic group. Data revealed that using of 3.5% cress seeds as a natural emulsifier agent succeed in prepare acceptable processed spread cheese sample and led to decrease plasma glucose level in Adult male albino rats.*

Keywords*— *Cress seeds, Lepidium sativum, Processed spread cheese, Rheological properties, Type-2 diabetes.

I. INTRODUCTION

The Nutritional and potential therapeutic value of food is a key characteristic in the development of new value-added products that are manufactured for health-conscious consumers [1][2]. Functional foods refer to foods or food ingredients that provide specific physiological beneficial effects and/or reduce the risk of chronic disease beyond basic Nutritional functions [3]. Processed cheese products are widely consumed as retail products (as spreads or slices) or as an ingredient in cheese-based dishes, including sandwiches, hamburgers, pizza, and lasagna. Their popularity as products may be attributed to several factors including inter alias, the diversity they offer in flavor, texture, and cooking properties; easy customization to cheese ingredient applications, adaptability to fast food trade; and their attractive packaging into convenient formats and shapes. Such diversity is controlled by changes in formulation, processing conditions and composition [4].

Processed cheese is produced by blending shredded natural cheeses of different types and degrees of maturity with melting salts, followed by heating the blend under a partial vacuum with a constant agitation until homogenous mass is obtained. In addition to natural cheeses other ingredients of both dairy and non-dairy origin may be included in the blend [5] [6]. Unripen cheeses such as White or Ricotta cheeses made by coagulating hot milk with an acid may also be used as ingredients in the process cheese blends. The use of these products in process cheese would be economically advantageous because (a) unripen cheese may be used directly from the manufacture without aging, (b) the yield is higher due to the recovery of both casein and whey proteins, and (c) unripen cheeses have very low bacterial counts at the time of manufacture [7]. Cheese whey has high biological and chemical oxygen demands, which make its disposal is a problem [8]. However, the use of cheese whey in processed cheese blends could potentially alter quality of the product. Various researchers studied the influence of incorporation of whey proteins on the functionality of processed cheese [9] [10].

Function of emulsifiers in food processing is to keep oil and water bound together. Unfortunately, some compounds used as emulsifiers are known to have potential health risks. Sodium phosphate is one such substance you'll occasionally find listed as an ingredient in processed cheese products which can damage the kidneys. Examples of other harmful emulsifiers are potassium phosphate, which may trigger allergic reactions, and tartrate which may cause diarrhea [11]. [6] revealed that use of tri-sodium citrate and sodium polyphosphate in cheese processing increased the oxidative stress in male mice that increased the toxicity

response on genetic materials, liver and kidney functions. So, an urgent demand for searching new materials used as emulsifying agents is still need.

Mucilages are polysaccharides complexes formed from sugar and uronic acid units. They form slimy masses in water are typically heterogeneous in composition. Mucilages are obtained mainly from seeds or other plant parts. Some are obtained from marine algae and from selected microorganisms [11]. Plant mucilages have been widely explored as pharmaceutical excipients [13] and have been known, since ancient times for their medical uses [14]. They are widely used in the industry as thickeners, water-retention agents, emulsion stabilizers, gelling agents, suspending agents, binders, film formers and sustained-release agents [15] [16] one of these seeds is cress.

Cress seed (*Lepidium sativum*) is a fast-growing annual herb belonging to the Brassicaceae family that are native to Egypt and west Asia, are rich source of proteins, dietary fiber, minerals and essential amino acids. They contain phenolic compounds which might be responsible for its strong antioxidant capacity. Toxicology studies of cress seeds revealed that cress seeds can be considered as non-toxic and safe. Previous studies have recommended cress seed in the treatment of hypertension, renal disease and diabetes which help to control glucose level [17]. It also shows many medicinal properties such as hypocholesterolemic, antidiarrheal, antispasmodic and laxative activities. It also has fracture healing hepatoprotective, diuretic, nephrocurative, nephroprtective, galactogogue, anti-inflammatory and antipyretic [18] [19].

Management of diabetes is being a tough task with the organic medicines which often associated with many side effects including hypoglycemic episodes and gastrointestinal disorders [20]. Recently, the world health organization (WHO) as encouraged the use of medicinal plants and their bioactive components to treat diabetic patients, as they are frequently considered to be less toxic than the synthetic ones, especially in countries where conventional treatment of diabetes seems insufficient [21].

Diabetes mellitus is a chronic metabolic disorder that is characterized by a relative or absolute lack of insulin, resulting in hyperglycemia. International Diabetes Federation has estimated the incidence of diabetes projection for the year 2015 to be 419 million adults and is expected to be 642 million by 2040 [22]. There are several forms of diabetes mellitus, the main are: type-1 and type-2. Type-2 (noninsulin-dependent diabetes, NIDDM) is a heterogeneous disorder of insulin resistance and pancreatic β-cell dysfunction [23] [24]. The rates of type-2 diabetes have increased markedly since 1960 as of 2015 there were approximately 392 million people diagnosed with type-2 diabetes compared to around 30 million in 1985, making up About 90% of all diabetes cases, which is equivalent to about 6% of the world's population [25]. In addition to serious health complications that associated with diabetes, an enormous economic cost is referred to diabetes. If untreated, it can lead to destructive conditions including metabolic problems, infection, macrovascular complications such as hypertension and stroke, microvascular complications as retinopathy, and diabetic foot disorders [26] [27].

Physico-chemical properties of cress seeds mucilage's were widely studied[28]. However, there are few controversial reports in the literature for using cress seeds mucilage's as dairy food supplements [29] [30]. Therefore, the present study describes the utilization of cress seeds instead of emulsifying salt in processed cheeses speared and the effect of this additive on the chemical, microbiological, rheological properties and organoleptic evaluation of the obtained processed cheese. The second objective of this study is to evaluate the modulatory effect of processed cheese spreads with 3.5% cress seed on the glucose level in diabetic rats.

II. MATERIALS AND METHODS

2.1. Materials:

- Fresh Buffalo's milk was obtained from Animal Production Research Institute, Ministry of Agriculture, Egypt.
- Ras cheese was obtained from Arabic Food Industrial Co. (Domty), 6th October City, Egypt. Commercial emulsifying salt (JOHA S9), special recommended for spreadable processed cheese making, was obtained from BK Ladenburg corp., GmbH, Germany.
- Citric acid was obtained from local market.
- Streptozotocin (STZ) (C8H15N3O7; molecular weight 265.22 Da) and nicotinamide (C6H6N2O; molecular weight 122.12 Da) were purchased from Sigma-Aldrich (St Louis, MO, USA).
- Citrate buffer (pH 4.5) was purchased from Bio-diagnostic (Dokki, Giza).
- Pure Crees seed (*Lepidium sativum*) were obtained from Suttons, Woodview Road, Paignton Devon TQ4 7NG Registered in England and Wales.

2.2. Methods:

2.2.1. Processing of cress seeds:

The seeds were grinded to powder of -100 mesh size and were stored in tightly capped glass bottles until used. The composition of the cress seeds varies widely between varieties and environmental conditions. Therefore, cress seed used in the present study was analyzed to explore its chemical composition of the ingredients used in the

manufacturing of processed cheese is presented in Table (1).

2.2.2. Manufacture of soft acid curd (cheese base):
Buffalo milk is an ideal raw material for manufacture of good quality cheese. Buffalo milk is standardized to a fat level of 6.0 %. The standardized milk was heated to 90ºC without holding. Thereafter, the temperature of milk was brought down to 70ºC and was coagulated at this temperature using 1 % citric acid solution. Citric acid solution was added with continuous stirring till clear whey separated out. After complete coagulation, the stirring was stopped and the coagulated mass (curd) was allowed to settle down for about 5 minutes. The whey was then drained through stainless steel strainer. The temperature of the content was not allowed to drop below 63ºC until this stage. The curd was collected and was filled in hoops (with holes on all its sides to facilitates the expulsion of whey) lined with clean fine cloth. The hoops containing curd was pressed for about 10-20 minutes [7]. Thereafter, the pressed block of curd was removed, cut into pieces. Reservation of whey product for re-use in processed cheese manufacturing process.

2.2.3. Manufacture of processed spread cheese:
Processed spread cheese samples were manufactured as mentioned by [6]. Seven different experimental batches of processed spread cheese were manufactured by mixing Ras cheese, soft acid which made as in previous and cheese whey. Commercial emulsifying salt (3%) was added as control. Cress seed was instead of emulsifying salt at six levels 0.5, 1.5, 2.5, 3.5, 4.5, 5.5% addition as well as control treatment**.** All treatments were processed in double jacket ban at 90-98 ºC/8-12 min, then placed in containers (100-120 g) and rapidly cooled to 10-14 ºC/30 min. All containers were stored in refrigerator at 8±2ºC for 3 months. Three replicates of each treatment were prepared.
Representative samples were taken for physico-chemical, rheological, microbial analysis and organoleptic assessment along storage period at zero time, 30, 60 and90 days. The formulations of processed cheese are presented in Table (2).

2.2.4. Experimental procedure:
Preliminary experiments showed that addition of 0.5 % cress seed gave very weak body & texture as well as flat flavor. On the other hand, 4.5, 5.5 % cress seed resulted in more viscous and hard consistency so, led to refuse these ratios.

2.2.5. Physico-chemical analysis:
Cress seed, Ras cheese, soft cheese, cheese whey and processed spread cheese were analyzed for moisture, fat, crude protein, ash and fiber according to the method of [31]. Total carbohydrate was calculated by difference of fat, protein and ash contents from the total solids of cress seeds. Minerals were determined using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPAES) according to [32] procedure. pH value was measured by type-digital pH meter (model HANNA HI9321).

2.2.6. Physical analysis:
Penetrometer readings, oiling off and melting index were also determined to reflect the physical properties of the processed cheeses. Melltability was measured using the meltability test apparatus as described by [33] and modified by [34]. Oil separation of processed cheese was determined according to [35]. The processed cheeses penetrometer was measured using a penetrometer (Kochler Instrument Co. Inc., USA) as described [36].

2.2.7. Microbiological tests:
The technique according to the [37] was used. Samples were examined when fresh and monthly along the storage period for total bacterial count, moulds & yeasts count, aerobic spore forming bacterial count and coliform bacterial count according to [38].

2.2.8. Organoleptic properties:
Organoleptic properties were carried out according to the Scheme of [39]. Sensory attributes of processed spread cheese product samples were evaluated by the staff members, Animal Production Research Institute, Ministry of Agriculture, Egypt.

2.2.9. Experimental Animals:
Adult male Wistar albino rats (*Rattus norvegicus*), weighting between 130 and 140 g. They were housed in suitable cages, and acclimatized to laboratory conditions for 1 week before the commencement of the experiments. The animals were provided with fresh tap water and standard rodent food pellets; and were humanely treated in accordance with the WHO guideline for animal care. The study design was approved by the Ain Shams University Research Ethics Committee.

2.2.10. Induction of type-2 diabetes:
Type-2 diabetes mellitus was induced in overnight fasted rats by a single intraperitoneal injection (i.p.) of 100 mg/kg body weight (b.w) of STZ, 15 min after a single i.p. injection of 110 mg/kg b.w of nicotinamide. STZ and nicotinamide were dissolved in citrate buffer (pH 4.5) and physiological saline, respectively, and

hyperglycaemia was confirmed by the determination of fasting blood glucose level after 3 days of STZ injection.

2.2.11. Animal grouping and treatments:

After one week of acclimation, the animals were randomized and divided into four groups and treated for 14 days as follow: **Group I** (normal control): the animals housed in suitable cages in the same conditions of the treated groups. **Group II** (Cress): the animals were orally and daily received processed cheese spreads with 3.5% cress seed as one diet via gavage. **Group III** (diabetic control): after induction of type-2 diabetes, the animals were housed in suitable cages in the same conditions of the treated groups and served as a reference group for the diabetic-treated group. **Group IV** (diabetic + cress): diabetic rats were administered processed cheese spreads with 3.5% cress seed as one diet orally and daily via gavage for 14 days from the beginning of the experiment.

At the end of the experiment, the weight of each animal was recorded and the animals were subjected to light diethyl ether anesthesia before sacrificing. The blood was collected into clean centrifuge tubes with anticoagulant, ethylene diamine tetra-acetic acid (EDTA), then was centrifuged in a cooling centrifuge (IEC centra-4R, International Equipment Co., Needham Heights, MA, USA) for 15 minutes at 3000 rpm and 4oC to obtain plasma.

2.2.12. Determination of the glucose level:

Blood glucose level was colorimetrically determined in the plasma according to the method of [40] using Diamond Diagnostic kit (dp International, Cairo, Egypt).

2.2.13. Statistical analysis:

Statistical evaluation was conducted with Instat Program GraphPad. Software, Inc, San Digeo, USA, version3. 6, Copyright©1992-2003 Results were expressed as mean ± SEM. The results were analyzed for statistical significance by One-Way ANOVA followed by Tukey-Kramer multiple comparisons post-test. Values of $P<0.05$ were regarded as significant [41].

III. RESULTS AND DISCUSSION

3.1Physico-chemical analysis:

The results presented in Table (3) shows the physico-chemical composition of processed spread cheese. Addition of cress seeds in the processed cheese slightly increased the total solids and decreased the moisture contents with the increase ratio of cress seeds. these changes were significant ($P<0.05$). Moisture variation can also affect the rheological properties, shelf life and sensorial characteristics [42].

In the same table, the fat and protein content of processed spread cheese gradually increased with the increased ratio of cress seeds. The differences between the control and treatments in fat and protein content were significant ($P<0.05$). This can be attributed to the fat content and protein in cress seeds [43] [44]. Calculating the fat/DM recorded significant differences ($P<0.05$) between the control and all treatments due to differences in the TS and fat contents of processed spread cheese. Wide variation in the ash content of processed spread cheese were reported by [45] [46]. due to differences in the NaCl content, emulsifying salt percentage and the use of different ingredients in different studies. The control cheese had the highest ash content due to the addition of percentage commercial emulsifying salt. On the other hand, the fibers content of processed cheese samples increased with the increased of the ratios of cress seeds in the product which may be attributed to the presence of fiber content in cress seed [43]. Fiber are linked to less cardiovascular disease and plays a role in gut health [47].

Minerals content of processed spread cheese samples was given in Table (3). The iron, potassium, phosphorus and zinc contents of processed spread cheese increased gradually with addition of cress seeds and differences were found significant ($P<0.05$) due to cress seeds contained high of iron, potassium, phosphorus and zinc content [43] [44]. The highest of iron, potassium, phosphorus and zinc contents were observed in Tr_3. However, control of processed spread cheese was lowest of minerals content in all processed spread cheese treatments. The pH values of processed spread cheese are shown in Table (3). Values were 5.73, 5.59, 5.55 and 5.51 for control, Tr_1, Tr_2 and Tr_3, respectively. Therefore, control cheese had the highest pH and it is decreased with increasing the ratios of cress seed so Tr_3 was the lowest one. Statistical analysis showed that both the percentages of cress seed had a significant effect ($P<0.05$) on the pH value of processed spread cheese.

3.2. Physical analysis:

3.2.1. Penetration values

Fig. (1) indicated the change of penetration values on fresh and during storage (8±2°C). It showed that the penetration values get similar score in Tr_3 and control, while higher values can be observed in Tr_1 and Tr_2. This mean that the curds of Tr_1 and Tr_2 were weaker and softer textures than control and Tr_3, due to different between the impact of cress seed powder and commercial emulsifying salt in terms of the ability to bind water and emulsifying.

Penetration values can be affected by addition whey during processing steps. It can bind more water as a denaturation effect which leads to increase the emulsification of the fat globules [48] [49]. At the same fig. it can be showed gradually decreased in penetration

values till 3 months in all treatments. This could be related to the interaction between cress seed and state of protein network as well as the changes in chemical composition during storage [50] [51].

3.2.2. Meltability

Meltability is an important character, which determines to a great extent, the quality of processed cheese. Fig. (2) showed that melting index of processed spread cheese containing of cress seeds increased gradually with increasing the ratio of cress seeds, while control was the lowest when fresh and during storage.

The melting index of all treatments even control tended to decrease as the storage period progressed, [46] [52] [53] reported that the changes in meltability values of stored samples could be due to the changes occurred in chemical properties of processed spread cheese such as pH, protein state, emulsifying salts and the slight decrease of moisture content. Data are in agreement with that of the analysis of variance showed that the meltability was significantly affected (P<0.05) by the percentages of cress seeds and storage period.

3.2.3. Oil separation index

Oil separation defect in the process cheese can arise due to variety of reasons as low or too high level of emulsifying salts [39]. As shown in Fig. (3), cress seeds showed a pronounced effect on the oil separation of processed spread cheese. Gradual decrease of oil separation can be observed with the increasing ratios of cress seeds.

This is could be due to the emulsion effect of this seeds; while oil separation index got similar score in Tr_3 and control. Oil separation index of stored samples increased with prolonging the storage period. Data are agreed with [54,55]. Analysis of variance showed that oil separation and storage period had significantly affected (P<0.05).

3.3. Microbial content

The microbiological analysis, including total bacterial counts, coliform counts, yeast and mold counts and aerobic spore forming bacteria of processed spread cheese samples was done to determine the effect of adding of cress seed instead of emulsifying salts. Total bacterial count for treatments were 27 $x10^2$, 24 x 10^2, 21 x 10^2 and 18 x 10^2 cfu/g for control, Tr_1, Tr_2 and Tr_3, respectively, the total bacterial counts of control and treatments were lower than that reported by [56] namely: 60-5000 cfu/g, and by [57] namely: 42-87 x 10^2 cfu/g in market processed cheese samples. In the overall results observed a decrease in the number of tested microorganisms in all processed spread cheese treatments in comparison to that obtained in cheese control. These results were similar to what found by [58]. A slightly increased in the total bacterial count was observed along storage period. Total bacterial count recorded $29x10^2$, $25x10^2$, $22x10^2$, and $19x10^2$ cfu/g for control, Tr_1, Tr_2 and Tr_3, respectively. Moulds and yeasts began to appear after 2 months in control cheese (data not shown), however, these results were disagreement with what was found by Mohamed (2004), who found that processed cheese were free from yeasts and moulds during storage at 5°C or 25°C. While Moulds and yeasts were not detected in processed spread cheese containing of cress seeds in fresh and through the storage period. This is due to the presence of cress seeds which contain several compounds as possess antimicrobial against food spoilage organisms [59] Coliforms and aerobic spore forming bacteria were not detected in all cheese treatments either when fresh or during the storage period. This may be due to the high hygienic condition during the preparation.

3.4. Organoleptic evaluation

One of the most important things that were kept in view was the consumer acceptability of the final product. The assessment was done by studying the characteristics like flavor, body, texture, color, appearance and overall acceptability of processed spread cheese and result are presented in Table (4). The obtained degrees recorded that flavor was improved with addition of cress seed powder. Control sample gained 35 score while fortified samples gained 37, 38 and 39 for 1.5, 2.5, and 3.5 % cress seed powder, respectively; The flavor score between control and the differences treatments were significant. Control sample gained the lowest score due to the addition immature cheese base (acid curd) at the highest level (70%) and small amounts of extra-mature cheese which lead to weak and flat flavor in the final product. This observation was agreed with the results obtained by other researchers who used immature raw materials for processing cheese [60].

Addition of cress seed was improved the flavor; [61] reported that cress seed is peppery, tangy flavor and aroma. [62] Reported that cress have been used primarily to add flavor to simple soups and in return get the health benefits. Body and texture of cheese was composite sensory attribute resulting from a combination of physical properties that are perceived by the senses of touch (tactile texture) and sight (visual texture) during consumption. In the same table, body and texture score of the different processed spread cheese prepared using different amounts of cress seed powder were 36±2.1, 35±1.2, 37±0.2.3 and 39±0.91 for control, Tr_1, Tr_2 and Tr_3, respectively. Statistical analysis showed that there was a significant difference (P<0.05) between them. Physico-chemical properties cress seeds mucilage's are

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used to improve body and texture in the processed spread cheese as thickeners, water-retention agents, emulsion stabilizers, gelling agents, suspending agents [15] [16]. The appearance got similar score in Tr_3 and control, while Tr_1 and Tr_2 showed lower score. As a result of the decrease in rate of cress seed which did not give the required appearance, strength, and structure. Also, Table (4) shows that the scores for colour attribute decreased significantly ($P<0.05$) with the increased addition of cress seed in the processed spread cheese.

Although, differences in colour scores between control and Tr_1 were not significant, statistical analysis showed that there was a significant difference ($P<0.05$) between treatments. The organoleptic evaluations showed that the sample prepared with cress seed powder at 3.5% (w/v) had highest overall acceptability and cress seed instead of emulsifying salt is an excellent; it also helps to create a smooth texture and a shiny appearance. Fig. (4) indicated acceptability of all processed spread cheese was reduced with the progress of storage period. Values of total score were 76, 79, 82 and 86 for control, Tr_1, Tr_2 and Tr_3, respectively. These results are in agreement with those obtained by Aly *et al*. (1995) [55]

3.5. Microstructure of processed cheese spreads:

Microstructure of cheese represents the spatial distribution of the compositional components (casein, minerals, fat, moisture and dissolved solutes such as lactose, lactic acid, soluble salts and peptides) [64]. Surprising, they are only a few systematic studies on the effect of the major solid components (fat and protein) and emulsifying salt types and concentrations on the microstructure of processed spread cheese. Studies on the cress seed instead of emulsifying salt on processed spread cheese as shown in Fig. (5).

Processed cheese with 3.5% cress seed (Tr_3) seems to be better than processed cheese (control) with a good dispersion fat particulate highly scatter in the hydrated wrapped casein mixture. Due to increasing dry mater content and the fat globules in cheese, it could be found a uniform structure of casein indicating that the moisture in processed spread cheese was mainly bound water combined with the fat globule and hydrated casein; it appears having much fat globule. Mixture formulation of (Tr_3) with the highest level of cress seeds improve the structure form, this is may be due to the excess of protein and fiber in cress seeds contents, which consciously increase the penetration values [42] and increase the meltability of the cheese [36]. Regarding the microscopic investigation, it was founded that processed spread cheese with 3.5% cress seed (Tr_3) is more effective on microstructure and in appearance than processed spread cheese (control).

3.6. Effect of processed cheese spreads with 3.5% cress seed on plasma glucose level (mg/dL):

As shown in Table (5) and Fig. (6), Plasma glucose level did not significantly change ($P>0.05$) in the group that received processed cheese spreads with 3.5% cress seed for 14 consecutive days as compared with the normal control group. However, the diabetic group showed a significant increase ($P<0.001$) in the plasma glucose level compared with the normal control one. Oral treatment of diabetic groups with processed spread cheese with 3.5% cress seed showed a hypoglycaemic effect as it significantly decreased ($P<0.01$) the plasma glucose level as compared with the diabetic group.

Medicinal plants provide health benefits. Recently, several studies have investigated the hypoglycaemic property of cress seed in diabetic animal models. STZ affected β-cells of islets of Langerhans by release of toxic radicals leading to β-cell death, as they are particularly sensitive to damage by NOx and free radicals because of their low levels of free radical scavenging enzymes [65,66,27]. This caused insufficient production of insulin and consequently the elevation of blood glucose level. In the present study, induction of type-2 diabetes with STZ/nicotinamide significantly increased the glucose level and this hyperglycaemic action of STZ was confirmed by many previous studies [24,67,68,69,70,71,72]

In the present study, treatment of diabetic groups with processed cheese spreads with 3.5% cress seed showed powerful antidiabetic properties, as it decreased blood glucose level. In a similar manner, the anti-hyperglycemic effect of cress seed was investigated in STZ-induced diabetic rats that were orally administrated cress seed aqueous extract for 16 days [73]. The hypoglycaemic action of the processed cheese spreads with 3.5% cress seed may be referred to the presence of linolenic acids, high concentrations of tocopherols, flavonoids, glycosides triterpenes, sterols and many alkaloids that present in the cress seed. These compounds have been demonstrated to be able to stimulate the β-cells of pancreas to release more insulin and to enhance glucose metabolism [73-75,). Moreover, the cress seed extract has been demonstrated to affect glucose homeostasis through several pathways as the inhibition of glucose production in the liver [76], the inhibition of renal glucose reabsorption [77] increasing both glucose uptake [78] and glucose metabolism in the muscle and adipose tissues [79] or the inhibition of intestinal glucose absorption [80].

IV. CONCLUSION

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It could be concluded that cress seeds powder can be consider as an excellent natural emulsifier could be replacement by commercial emulsifier in the manufacture of processed spread cheese at the level of 3.5% (w/v) which gain the highest overall acceptability. Also, it could be concluded that processed spread cheese with 3.5% cress seed as one diet showed hypoglycemic activity and promise a new natural antidiabetic product.

Table.1: Chemical composition of all ingredients used in manufacture of processed spread cheese samples.

Composition %	Ras cheese	Cheese base (Acid curd)	Fresh whey	Cress seed powder
Total Solids	61.83	32.8	6.88	95.89
Fat	28.11	14.5	0.6	26.68
Total protein	26.70	13.0	0.8	23.27
Total carbohydrates	1.22	3.0	4.8	34.24
Fiber	--	--	---	7.3
Ash	5.8	2.3	0.68	4.4

Table.2: Formulations of processed spread cheese containing different contents of Crees seed.

Ingredients (%)	Control	Tr	Tr_1	Tr_2	Tr_3	Tr_4	Tr_5
Soft cheese	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Ras cheese	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Emulsifying salt	3.0		-	-	-	-	-
Cress seed	-	0.5	1.5	2.5	3.5	4.5	5.5
Cheese whey	18.5	21.0	20.0	19.0	18.0	17.0	16.0
Total	100	100	100	100	100	100	100

control: processed spread cheese with commercial emulsifying salts (3%).
Tr : processed spread cheese with Cress seeds (0.5%).
Tr_1: processed spread cheese with Cress seeds (1.5%).
Tr_2: processed spread cheese with Cress seeds (2.5%).
Tr_3: processed spread cheese with Cress seeds (3.5%).
Tr_4: processed spread cheese with Cress seeds (45%).
Tr_5: processed spread cheese with Cress seeds (5.5%).

Table.3: Physico-chemical analysis of processed spread cheese containing different percentages of Cress seed Mean ± standard deviation.

Composition	Control	Tr_1	Tr_2	Tr_3
Moisture %	57.59 ± 2.31^{a}	59.88 ± 1.34^{a}	58.76 ± 2.12^{b}	57.50 ± 3.52^{c}
Total Solid %	42.41 ± 1.42^{a}	40.12 ± 2.71^{c}	41.24 ± 2.33^{b}	42.50 ± 1.62^{a}
Fat %	16.57 ± 0.11^{b}	16.97 ± 0.07^{b}	17.68 ± 0.04^{a}	17.84 ± 0.05^{a}
Fat/DM %	39.10± 2.52	42.30± 2.21	42.87± 1.21	42.98± 3.01
Total Protein %	14.59 ± 0.01^{b}	14.98 ± 0.11^{b}	15.34 ± 0.12^{ab}	15.87 ± 0.06^{a}
Ash %	4.08 ± 0.04^{a}	2.97 ± 0.01^{c}	3.04 ± 0.06^{b}	3.13 ± 0.08^{b}
Fiber %	ND	0.11 ± 0.13^{c}	0.18 ± 0.07^{b}	0.25 ± 0.01^{a}
Iron%	ND	0.11 ± 0.01^{c}	0.18 ± 0.01^{b}	0.23 ± 0.03^{a}
Potassium%	97.73 ± 0.12^{d}	115.63 ± 1.0^{c}	127.58 ± 1.1^{b}	135.43 ± 1.13^{a}
Phosphorus%	512.12 ± 0.23^{d}	521.41 ± 0.12^{c}	527.62 ± 0.15^{b}	531.08 ± 0.3^{a}
Zinc%	4.1 ± 1.0^{d}	4.18 ± 1.3^{c}	4.23 ± 0.05^{b}	4.28 ± 1.3^{a}
pH	5.73± 0.08	5.59± 0.14	5.55± 0.03	5.51± 0.06

Means with the same small letters are not significantly ($p \leq 0.05$)
control: processed cheese spread with commercial emulsifying salts (3%).
Tr1: processed cheese spread with Cress seeds (1.5%).
Tr_2: processed cheese spread with Cress seeds (2.5%).
Tr_3: processed cheese spread with Cress seeds (3.5%).

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Table.4: Organoleptic evaluation of processed cheese spreads containing different percentages of cress seed Mean ± standard deviation

Organoleptic properties	Control	Tr_1	Tr_2	Tr_3
Flavor (40)	35±1.1d	37±2.3c	38±1.6b	39±1.4a
Body &Texture (40)	36±2.1c	35±1.2d	37±2.3b	39±0.91a
Appearance (10)	9±1.0a	5±2.1c	6±1.8b	9±2.4a
Color (10)	9±0.5a	8±1.1ab	7±0.9b	6±0.7c
Total (100)	89±1.9b	85±1.3c	88±1.6b	93±1.5a

Means with the same small letters are not significantly ($p \leq 0.05$)

control: processed cheese spreads with commercial emulsifying salts (3%).

Tr_1: processed cheese spread with Cress seeds (1.5%).

Tr_2: processed cheese spread with Cress seeds (2.5%).

Tr_3: processed cheese spread with Cress seeds (3.5%).

Table.5: The Mean values ± SEM of plasma glucose level (mg/dL) of control and diabetic rats treated with cress seeds.

	Control	Diabetes	Cress	Diabetes+Cress
Glucose (mg/dL)	90.125±4.44	160.9±2.39***	102.7±7.74^{ns}	127.65±4.50##

ns: non-significant with the control group; ***$P<$ 0.001 and ## $P<$ 0.01 significantly different from the control and diabetic group, respectively.

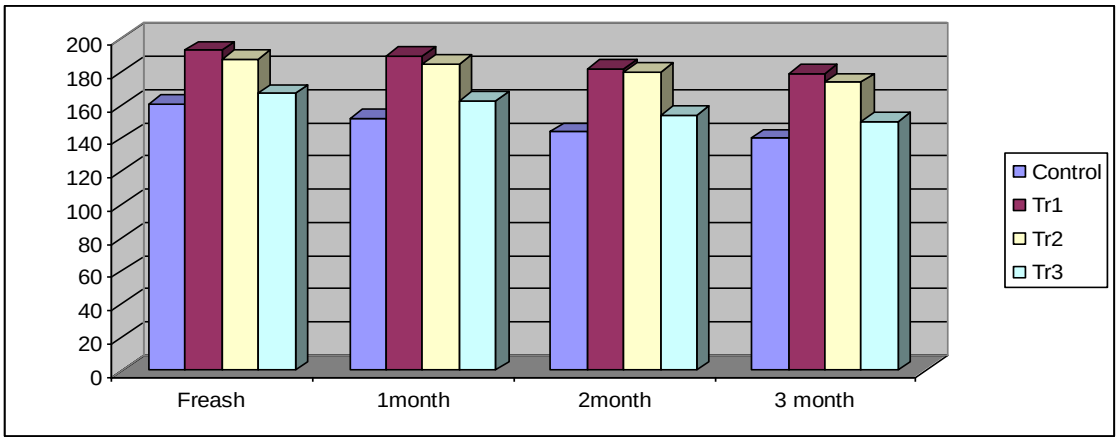

Fig. 1: Penetration values of processed spread cheese containing different percentages of cress seeds during storage period.

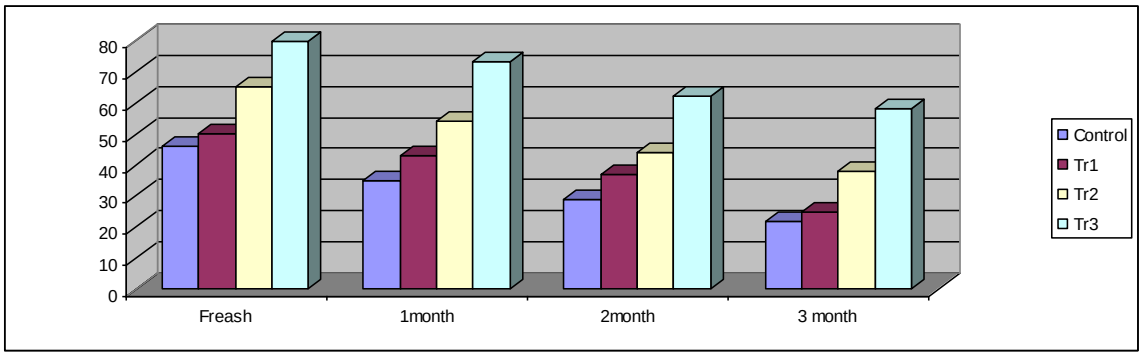

Fig.2: Meltability of processed cheese spreads containing different percentages of cress seeds during storage period.

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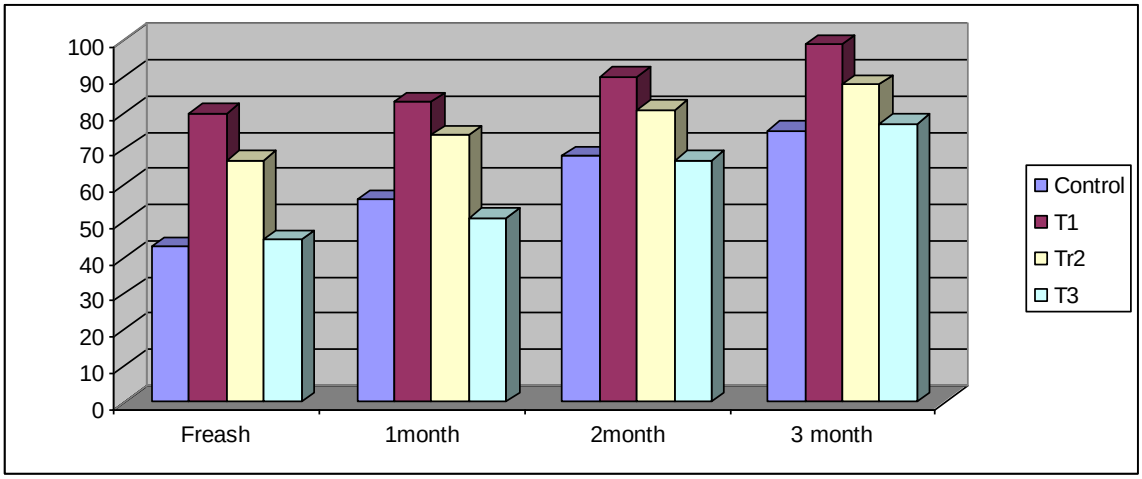


Fig.3: Oil separation index of processed cheese spreads containing different percentages of cress seeds during storage period.

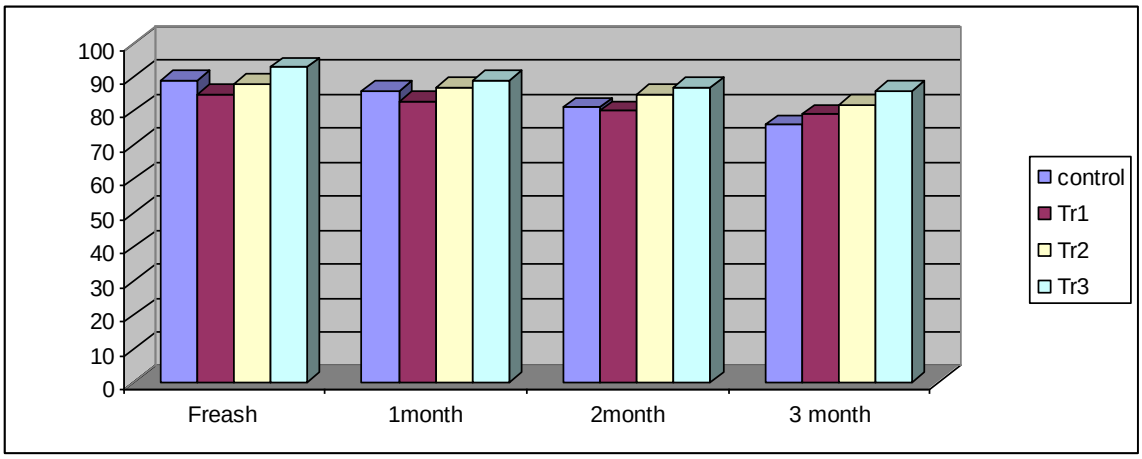
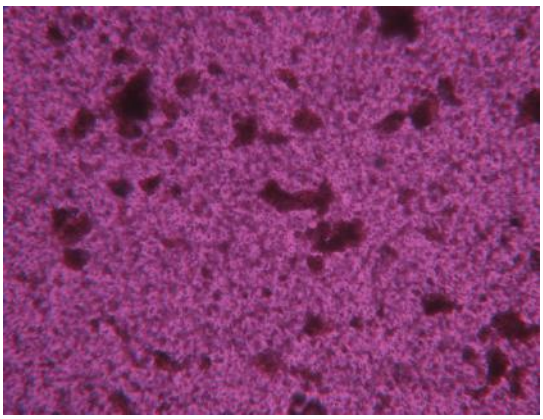
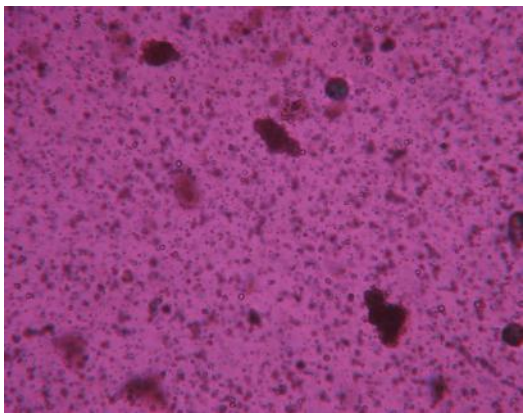


Fig.4: Overall acceptability of processed cheese spreads samples containing different percentages of cress seed during storage period.



processed spread cheese with Cress seed (3.5%).



processed spread cheese with commercial emulsifying salts.

Fig.5: Microstructure of processed cheese.

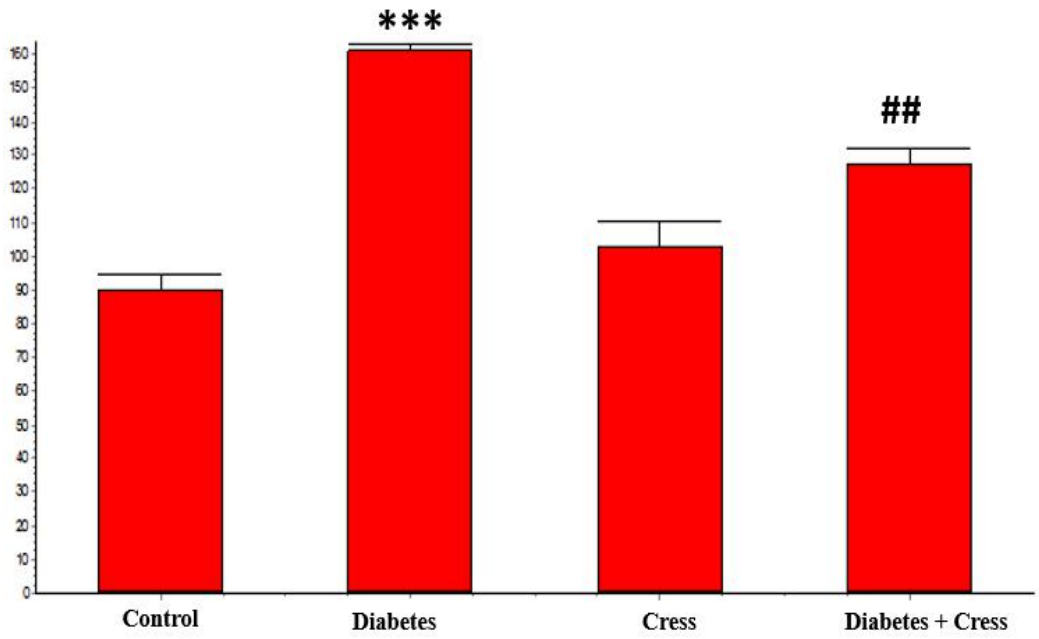


*Fig.6: Plasma glucose level (mg/dL) in control and diabetic male albino rats treated with processed cheese spreads with 3.5% cress seed. The data represent the means ± SEM.***P<0.001 and ## P<0.01 significantly different from the control and diabetic group, respectively.*

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