Production of Protein-Rich Kiwi Fruit Jam Using Spirulina Algae

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Abstract:

This study aimed to evaluation the effect of applying two levels of spirulina algae to production protein-rich kiwi fruit jam as functional foods to improve body functions, provide health benefits and nutritional balance as a result of mixing them. Three samples of kiwi jam were prepared: First was the control sample (S1), Second was kiwi jam enriched with 5% spirulina algae (S2), and third was kiwi jam enriched with 8% spirulina algae (S3) by replacing in sugar content. The kiwi jam samples S1, S2, and S3 were examined for protein, ash, fiber, moisture, fat and carbohydrates. The approximate composition of kiwi jam S3 and S2 revealed a notable rise in the nutrient content (fiber, protein, and fat) due to incorporating spirulina algae with compared to the control kiwi jam. That results showed the control kiwi jam sample is a rich source of carbohydrates while poor in protein and other nutrients, but the adding algae to the kiwi jam leads to an increase content of protein which was evident in our results of the protein content of the second sample, 4.34±0.06 and the third, 6.48±0.32, compared to the control sample, 1.18 ±0.04.

Spirulina algae, rich in essential amino acids, make fortified kiwi jam a complete protein source. The study recommends spirulina-fortified functional foods for their high health, nutritional value, protein, and dietary fiber content, especially for children, teenagers and athletes.

Key words: Spirulina, Functional foods, Kiwi fruit, antioxidant, high protein jam.

Introduction:

Functional foods are generally described as natural or manufactured items that, when consistently eaten in a varied diet and at effective levels, can produce additional health-benefiting effects over and above the basic nutrition. Which helps decrease the likelihood of non-communicable illnesses such as: cardiovascular disease, stroke, type 2 diabetes, and cancer **(Da Rosa *et al*., 2015; Granato *et al*., 2020)**.

Kiwi fruit belongs to the genus Actinidia and family Actinidiaceae. Other names for kiwi fruit include Chinese gooseberry, Mihoutau, and Macaque peach **(Tyagi *et al*., 2015)**. Almost all kiwis are eaten fresh, but some are turned into syrups, leather, spirits, dried, frozen, and lyophilized goods, juices, purees, sweets, and fortified beverages **(Guroo *et al*., 2017)**. It contains significant amounts of potassium, dietary fiber, folate, and other minerals in addition to being a powerful abundant supply of vitamins A, B, C, E, and K **(Richardson *et al*., 2018).** Triterpenoids, saponins, amino acids, carotenoids, carbohydrates, and sugars are among the phytochemicals that have been identified in kiwis. Phenolic substances, including flavonoids, polyphenols, anthraquinones, and coumarins, have also been identified. These ingredients provide a variety of pharmacological effects **(Khutare and Deshmukhs., 2023)**. Additionally, it aids in the production of collagen protein, which promotes skin that is youthful and flexible by shielding the skin from damaging UV rays. It contains a lot of actinidin, a proteolytic enzyme that helps the stomach and small intestine break down complicated protein molecules **(Richardson *et al*., 2018)**. According to **(Singh *et al*., 2018)**, It is applied to both prevent and treat a variety of cancers, including liver, lung, and stomach cancer**.** There are a many vital minerals found in kiwis. These minerals have Different bioavailabilities based on rate of absorption of the mineral and are essential for several metabolic processes occurring in the human body **(Chawla *et al*., 2019, 2020)**.

Numerous investigations into the Pharmacological characteristics and health advantages of kiwis have been

conducted. Antioxidant, anti-inflammatory, anti-hypertensive, anti-diabetic, antithrombin, anti-asthmatic, hepatoprotective, anti-platelet, anti-nociceptive, anti-microbial, anti-constipation, anticarcinogenic, antifungal, antiviral, and antitumor effects are just a few of the many biological effects that have been noted. It offers numerous health advantages due to its extensive pharmacological profile. It also protects against cardiovascular disease, cancer, and HIV/AIDS. It has a major function in correcting metabolic disorders like low-density lipoprotein and dyslipidemia, vascular inflammation, incorrect glucose metabolism, hypertension, and hemostatic disorders **(Al-Naimy *et al*., 2012; Satpal *et al*., 2021)**.

Spirulina is included at many nutritional supplements, functional foods and therapeutic foods due to its high chemical makeup gives it nutritional benefit. It is applied to certain food product ingredients, like dairy,biscuits, make fruit items, popcorn, beverages, frozen desserts, nutritional drinks, gourmet snack bars, and seasonings. Although spirulina can be ingested at any age, including pregnancy, maturity and young children benefit most from it during this time of growth, particularly between the ages of one and six **(Anitha and Chandralekha, 2010; Dillon, 2014;Cho *et al*., 2020; Alfadhly *et al*., 2022)** . For adult people, the safe suggested intake of spirulina is roughly 3–10 g/d, with a maximum of 30 g/d **(Sotiroudis and Sotiroudis, 2013)**.

Spirulina perfectly fits the definition of a nutritional supplement because of its protein content and its protective properties against non-communicable diseases such as cancer, diabetes, kidney disorders, high blood pressure, infertility **(Fantechi *et al*., 2023)**, cardiovascular diseases (CVDs), and other diseases can be prevented by inhibiting the activity of NADPH (nicotinamide adenine dinucleotide phosphate)oxidase, by a chromophore phycocyanobilin(A pigment with a blue hue) found in spirulina **(Gogna *et al*., 2023)**.

Spirulina supplementation improved cerebral cortical thickness, decreased oxidative brain damage, and activated microglia and astrocytes, among other beneficial benefits on neurological conditions **(Sinha *et al*., 2020)**. Fatty acid that helps lower the risk of some chronic diseases like diabetes and cancer is

γ-linolenic acid **(Choopani *et al*., 2016)**. Consequently, haematological indicators, insulin sensitivity, and body weight were increased when 19 g/d of spirulina was supplemented. It also promotes the production of Lactobacilli species, which are necessary for enhancing gastrointestinal health **(Christaki *et al*., 2011)**. Spirulina was shown to have anti-carcinogenic properties, as evidenced by its ability to reduce tumor size by 30%, as well as abdominal edema associated with hepatocellular carcinoma (HCC) and liver enzymes, which were otherwise elevated **(Mathew *et al*.,1995; Mahmoud *et al*.,2021)**.

Spirulina effectively lowers blood pressure (BP) **(Brito *et al*., 2020)**.

In many nations, "Spirulina" is the trade name given to blue-green algae dried biomass of the cyanobacterium Arthrospira platensis which a popular and safe food source. The National Health Surveillance Agency (ANVISA) and the Food and Drug Administration (FDA)2002 , have both approved it, and because it has no toxicological adverse effects, it is regarded as generally safe for both humans and animals **(Habib *et al*., 2008; Navacchi *et al*., 2012; Priyadarshani and Rath, 2012 ; Morsy *et al*., 2014)**.Despite having a high protein content, the FDA only allows 0.5 to 3.0 grams of spirulina per serving as a food additive, based on the GRAS (generally recognized as safe) designation **(Mao *et al*.,2005; Patel *et al*.,2006 & Narmadha *et al*.,2012)**. The primary characteristic of spirulina is its high protein content, which is roughly 60% on a dry weight basis**(Muys *et al*., 2024)** When compared to the production of animal protein or plant-based substitutes, the cultivation of spirulina offers notable environmental benefits **(Fantechi *et al*., 2023)**, due to its high protein content and the presence of other bioactive compounds it's referred to as "the food of the future, the superfood", NASA has used it as a dietary supplement in space**(Amin *et al*., 2024)**. Being one of the best providers of macronutrients, micronutrients and other bioactive substances like zeaxanthin and β-carotene, Additionally, spirulina is known as a complete food**(Gogna *et al*., 2023)**. Fatty acids from spirulina, particularly polyunsaturated fatty acids, may be utilized in certain diets to treat problems of lipid metabolism **(Li *et al*., 2019)**. Additionally, Spirulina contains

the nine necessary amino acids **(Bortolini *et al*., 2022)**. Therefore, spirulina can be regarded as a source of both necessary and non-essential amino acids, which could enhance diets that don't contain a lot of protein **(Bashir *et al*., 2016)**.

Because of these promising benefits of Kiwi fruits and Spirulina algae, the present study was carried out to strengthen of Kiwi jam, which is a product low in protein content and high in energy and carbohydrates by fortified with Spirulina algae, to become a functional food high in its energy, protein and vitamins content and other bioactive components.

Materials and Methods:

Raw materials (Kiwi (*Actinidia deliciosa*) - Sucrose - Citric Acid - Pectin - Spirulina algae) were bought in Giza, Egypt, at the local marketplace.

All chemical analysis of extracts was done in the Food Safety and Quality Control Lab, in Cairo University's Faculty of Agriculture in Giza, Egypt.

Methods:

The Kiwi jam was produced with Spirulina algae added as an antioxidant and antifungal to increase its nutritional value. The Kiwi jam was tested for DPPH and pH, as well as sensory tests (taste, smell, texture, color, porosity, general acceptance) and chemical composition. (moisture, ash, protein, fat, and carbs) were measured,

Three samples of Kiwi jam were used:

Sample (1): control.

Sample (2): Kiwi jam with 5% Spirulina.

Sample (3): Kiwi jam with 8% Spirulina.

The fruit (Kiwi) was cut into small pieces and left to soak for a period with white sugar (sucrose) and weights of citric acid, pectin and the amount of algae used were prepared to prepare control jam free of algae and another fortified with spirulina algae.

Kiwi jam Preparation:

1.For a whole day, combine 50 grams of kiwi and 45.8 grams of sugar in a saucepan.

2. Next, pour all of these ingredients into a pot and heat it to medium while stirring constantly.
3. Next, while still stirring, add 4 grams of algae to the remaining ingredients.
4. Add 0.1 grams of pectin and 0.1 grams of lemon salt to the jam just before it's done cooking.
5. A refractometer is used to measure the jam concentration after a sample is obtained, cooled, and reached at 68%.
6. The fire is extinguished in order to fill sterile jars, which are then placed upside down and stored there until the tests are completed.

Table (1) Experimental Kiwi Jam Formula and Control Kiwi Jam

Ingredients	**Control**	**Kiwi jam with 5%SP**	**Kiwi jam with 8% SP**
Kiwi	50gm	50gm	50gm
sugar	49.8gm	47.3gm	45.8gm
lemon salt	0.1gm	0.1gm	0.1gm
pectin	0.1gm	0.1gm	0.1gm
Spirulina	-	2.5gm	4gm

Chemical Composition of Kiwi jam:

Determination of moisture, proteins, fats, ash and crude fiber contents in extracts were according to **AOAC (2016)**. Protein content was determined by Kjeldahl technique **AOAC (2005)**, using a factor of 6.25, carbohydrate content was determined using the **AOAC (2000)** difference.

Total carbohydrates = 100 - (g protein+ g fat +g ash + g fiber).

DPPH Radical-Scavenging Activity:

A sample of Kiwi jam (0.1 g) was prepared in 50ml methanol. An aliquot of the extract was added to DPPH radical (100 µl, 0.2 mM) dissolved in methanol **Brand - Williams, *et al.*, (1995)**.

Microbiological analysis:

Samples preparation:

In order to provide adequate dilutions for the microbiological analysis, 25 g of each sample were combined and

homogenized in a sterile mixer, and ten-fold dilutions of homogenates or liquid samples were made and inoculated into selective medium plates.

Yeasts and molds count:

The number of yeast and mold colonies was measured and quantified per gram or milliliter of the sample **FDA (2002)**.

Sensory analysis:

Sensory evaluation of jam was carried out by a 10 panelists Students and staff of the Faculty of Sports Sciences, Helwan University, Egypt. Samples of jam were prepared one day earlier before the evaluation, Each panelist was asked to evaluate jam samples, according to color, flavor, taste, texture and general appearance by using the method **Wichchukit & O'Mahony (2015).** Each sensory attribute was rated on a 9-point hedonic scale: extremely liked –9, very much liked –8, moderately liked –7, slightly liked –6, neither liked nor disliked –5, slightly disliked –4, moderately disliked –3, very much disliked –2 and extremely disliked –1.

Ethical Considerations:

A research permit was obtained initial approval at 29/12/2024, from Fayoum University Supreme Committee for Scientific Research Ethics. Participants were informed of the study objectives and the safety of the product components, and the interviewer requested their consent to participate. Participants were provided with feedback after data analysis, and were assured of the confidentiality of the information shared.

Measurement of Color:

A Minolta Colorimeter CR-300 (Konica Minolta Business Technologies, Inc., Langenhagen, Hannover, GERMANY) was used to measure the color of Kiwi jam samples as CIE L*, a*, and b* values. The L*, a*, b* system (psychometric light L*, psychometric tone a*, and chroma b*) was used to define the color parameters.A* values range from - (greenness) to + (redness), b* values range from - (blueness) to + (yellowness), and L* values range from black to white, representing lightness in this coordinate system. The following formula was used to get the

total color change (ΔE) **(Barreiro *et al.*, 1997; Rajchl *et al.*, 2010)**.

$$\Delta E = \sqrt{(L - LC)2 + (a - ac)2 + (b - bc)2}$$

Physico chemical analysis:

A Jenway PH meter was used to measure the pH. Using phenolphthalein as the indicator, titration with a 0.1 N NaOH solution was used to evaluate titratable acidity (**AOAC, 2005**). The moisture content was subtracted from 100 to determine the total solid. Using an Abbe refractometer2 (Carl Zeiss GENA, GDR), the total soluble solid was calculated.

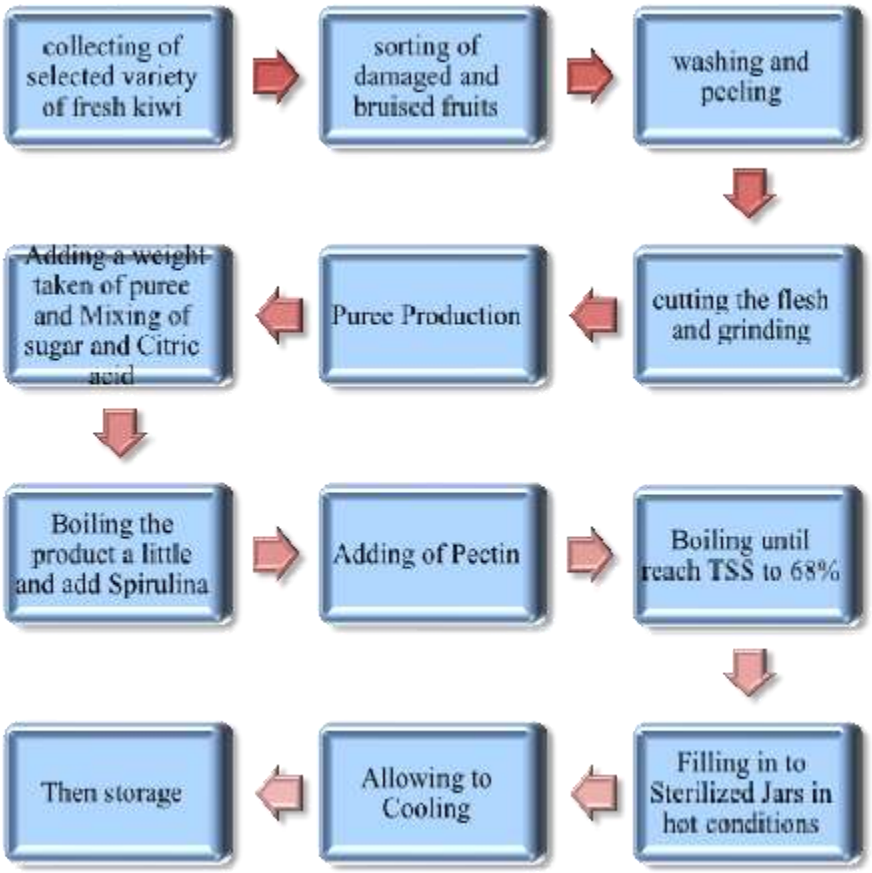

Figure 1: preparation of materials.

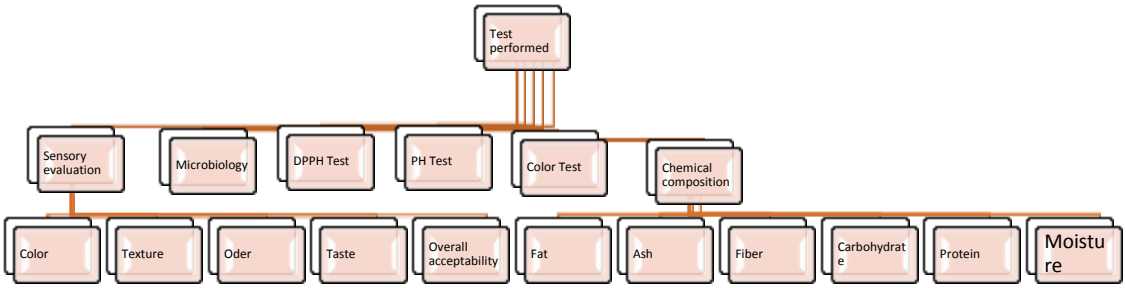

Figure 2: Chemical testing for samples.

The Price of 100 gm Kiwi Jam with 8% Spirulina Is 23 LE

Daily needs of kiwi jam fortified with spirulina algae:

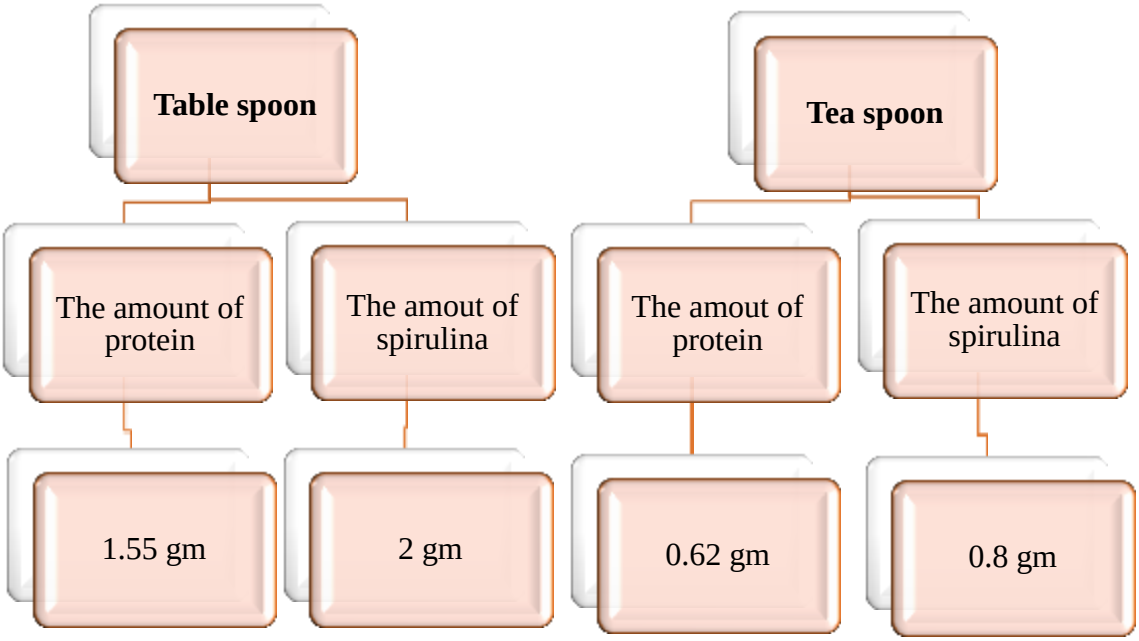

Figure 3: Daily needs of kiwi jam fortified with spirulina algae

The baby's needs of protein=2.2gm protein / kg of body weight
The adult's needs of protein=0.8gm protein / kg of body weight

Statistical analysis:

One-way ANOVA was used for the statistical analyses, which were performed in triplicates. The data were expressed as mean ± standard deviation with a p value confidence level of < 0.05. **Snedecor and Cochran, (1989)**.

Results and Discussion:

Based on statistical analysis after preparing kiwi jam only as control sample(S1), kiwi jam fortified with spirulina algae5% (S2) and kiwi jam fortified with spirulina algae 8%(S3) analyzing moisture, ash, protein, fat, fibers and carbohydrate in (S1, S2 and S3) samples table (2) illustrated the following:

Percentage of moisture content in the control jam more than moisture content in (S2 and S3) jam. This is because the added spirulina algae is in the form of a very low moisture dry substance = 5.53%, in addition to the fact that increasing spirulina algae content of the jam led to an increase in protein content in it, and thus the protein bound part of the water in the jam, so the moisture decreased in S2 and S3 (30.35±0.37; 28.24±0.14 respectively) compared to the control jam **(Ashoush and Mahdy.,2019)**.

A relative increase in the percentage of ash or Inorganic materials in the treated kiwi jam by 8% compared to the treated jam by 5% compared to the untreated jam, This is due to the high content of Spirulina algae in various minerals, especially iron, calcium, phosphorus, and potassium, which makes it a suitable nutritional supplement, especially for vegetarians **(Ashoush and Mahdy., 2019)**. **El Shafai and Abdallah, (2023)** demonstrated that adding 0.5% spirulina to a sample of salty biscuits significantly raised the amount of calcium in the diet and Iron, which is essential for keeping healthy blood, is especially abundant in spirulina.

percentage of protein in kiwi jam S3 > S2 jam > control jam because jam alone is a rich source of carbohydrates while poor in protein, and the percentage of protein per 100 grams of spirulina algae was 50.82 grams. When algae is added to kiwi jam leads to increase in the percentage of protein in it (S2=4.34±0.06; S3= 6.48±0.32), in addition to the fact that algae contain all the essential amino acids, which makes fortified kiwi jam a complete source of protein in terms of quality and nutrition **(Ashoush and Mahdy., 2019).**

Percentage of fat in kiwi jam 8% > jam 5% > control jam. The reason for this is that the percentage of fat per 100 grams of spirulina algae = 8.37 grams, so when the percentage of algae

addition increases, the amount of fat in the jam increases, which increases the absorption of vitamins (A, D, E, K) in the body **(Ashoush and Mahdy., 2019)**. Lipids make up only a minor portion of spirulina, about 5–10% of its dry weight, Omega-3 and omega-6 fatty acids are among the several fatty acids that make up spirulina's lipid composition **(Soni *et al*., 2017)**.

Percentage of fiber content in treated jam 8% spirulina algae more than treated jam 5% while it is more than untreated jam, This is due to the fact that kiwi fruit contains 1.40% Fiber, which helps maintain human health by reducing cholesterol levels in the body and improving general health, and spirulina algae contains 4.90% crude fiber, which is attributed to the high percentage of fiber in treated jam **(Ragab *et al*, .2019; Ashoush and Mahdy,. 2019).**

The percentage of carbohydrates in the three samples were nearly and the differences between them are slight numbers that do not affect the value of the jam as a food source rich in carbohydrates that stimulates appetite and provides fast energy. This is because the percentage of carbohydrates per 100 g of algae = 21.90 g. Spirulina has a comparatively low carbohydrate content, making up about 15% to 20% of its dry weight **(Grosshagauer *et al*. ,2020)**.

The more the amount of algae added, the higher the percentage of (protein - ash - fat - fiber) and the humidity decreased and the carbohydrates changed slightly **(Bekele *et al*, 2020)**.

Table (2) Chemical Composition of Experimental Kiwi Jam and Control Kiwi Jam on fresh weight

Samples	Moisture	Ash	Protein	Fat	Fibers	Carbo-hydrate
S1	$33.35^{a}\pm0.30$	$0.42^{c}\pm0.03$	$1.18^{c}\pm0.04$	$0.6^{c}\pm0.02$	$1.15^{c}\pm0.06$	$63.3^{a}\pm0.24$
S2	$30.35^{b}\pm0.37$	$0.81^{b}\pm0.08$	$4.34^{b}\pm0.06$	$1.01^{b}\pm0.01$	$1.29^{b}\pm0.07$	$62.2^{b}\pm0.1$
S3	$28.24^{c}\pm0.14$	$1.2^{a}\pm0.06$	$6.48^{a}\pm0.32$	$1.24^{a}\pm0.05$	$1.46^{a}\pm0.04$	$61.38^{c}\pm0.12$

S1=control; S2=Kiwi jam with 5% Spirulina; S3=Kiwi jam with 8% Spirulina. Mean values in each column having different subscript are significantly different at $P< 0.05$

Table (3) Color Test of Experimental Kiwi Jam and Control Kiwi Jam

Samples	L	a*	b*
S1	$34.78^{a}\pm0.50$	$5.71^{a}\pm0.11$	$-10.18^{a}\pm0.06$
S2	$26.23^{b}\pm0.05$	$2.48^{b}\pm0.02$	$-1.88^{b}\pm0.06$
S3	$24.82^{c}\pm0.05$	$1.90^{c}\pm0.07$	$-2.79^{c}\pm0.09$

S1=control; S2=Kiwi jam with 5% Spirulina; S3=Kiwi jam with 8% Spirulina. Mean values in each column having different subscript are significantly different at $P < 0.05$.

Table (3), illustrated that the color in the control jam is lighter than(S2) jam and the (S3) jam, the more spirulina algae added to jam the darker color. Control jam is slightly greenish yellow while treated jam is somewhat predominant greenish blue, this indicates a change in color after adding different ratios of spirulina algae and minor changes in color between different ratios (S2, S3) the color of the treated jam acceptable by the consumer (Nouri *et al*,.2018).

Table (4) Microbiology Test of Experimental Kiwi Jam and Control Kiwi Jam (Mold &Yeast)

Samples	concentrated jam	Diluted jam
S1	clear	clear
S2	clear	clear
S3	clear	clear

Sample 1=control; Sample 2=Treatment jam with 5% spirulina; Sample 3=Treatment jam with 8% spirulina

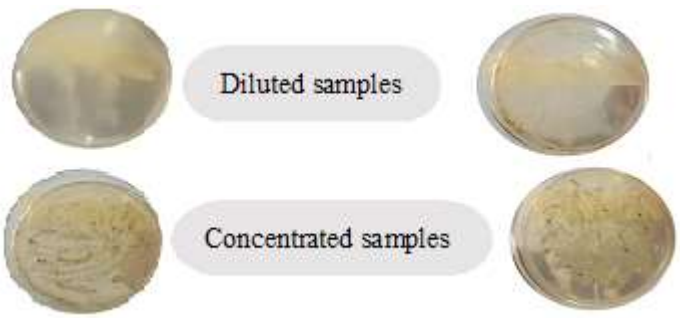

Table (4) showed that microbiological tests on jam samples (S1,S2 and S3) "No microbiological growths occurred on all Petri

dishes, whether for fungi, yeasts or bacteria. This is because the sugar content of the jam is high, which inhibited the growth of bacteria, and the jam was cooked at a temperature higher than 100 degrees Celsius, which led to the death of all fungi and yeasts. Then closing the jar after cooking prevented the jam from being contaminated with fungi and yeasts present in the surrounding atmosphere **(Bekele *et al*,.2020; Afoakwah *et al*,.2023).**

Table (5) DPPH Test of Experimental Kiwi Jam and Control Kiwi Jam

Samples	Inhibition%
S1	1.15^{c}±0.03
S2	37.14^{b}±0.13
S3	42.57^{a}±0.40

S1=control; S2=Kiwi jam with 5% Spirulina; S3=Kiwi jam with 8% Spirulina. Mean values in each column having different subscript are significantly different at $P < 0.05$

Percentage scavenging effect or Inhibation in treated jam 8% > jam 5% > control jam, this is due to the richness of kiwi fruit in flavonoids, zeaxanthin, b-carotene, chlorophyll and many phenols, which have strong antioxidant effects, and the presence of phycocyanin, carotenoids and phenolic compounds in spirulina algae, which works to inhibit free radicals in the human body and prevent oxidative stress (Ragab *et al*, .2019; Hussein *et al*, .2021; Gogna *et al*, .2023). spirulina algae enhance phenolic compounds and antioxidant activities (Lafarga *et al*.,2020).

Table 6: PH Test of Experimental Kiwi Jam and Control Kiwi Jam

Samples	PH
S1	3.35
S2	3.24
S3	3.12

S1=control; S2=Kiwi jam with 5% Spirulina; S3=Kiwi jam with 8% Spirulina

Table (6) showed slight differences in PH levels between the control sample, the sample treated with 5% Spirulina, and the sample treated with 8% Spirulina, all within the permissible range according to the specification (PH=2.8-3.4). In agreement with our results Tifani *et al*., (2018) found that while the technique had

no effect on the jam's qualities, it did alter the physicochemical characteristics of the kiwifruit pulp, causing notable variations in color and PH between varieties.

Table (7) Sensory Evaluation of Experimental Kiwi Jam and Control Kiwi Jam

Samples	color	Taste	Oder	Texture	Overall acceptance
S1	$9.93^{a}\pm0.27$	$9.43^{a}\pm0.65$	$9.64^{a}\pm0.63$	$9.86^{a}\pm0.36$	$9.71^{a}\pm0.47$
S2	$9.14^{b}\pm0.53$	$9.29^{a}\pm0.61$	$9.35^{a}\pm0.92$	$9.86^{a}\pm0.36$	$9.56^{a}\pm0.51$
S3	$9^{b}\pm0.79$	$8.71^{b}\pm0.73$	$9.21^{a}\pm0.80$	$9.07^{b}\pm0.83$	$8.64^{b}\pm0.63$

S1=control; S2=Kiwi jam with 5% Spirulina; S3=Kiwi jam with 8% Spirulina. Mean values in each column having different subscript are significantly different at $P < 0.05$

Table (7), showed that Kiwifruit enriched with Spirulina algae well received by consumers in terms of (color, taste, smell, texture and overall acceptance) for the 5% and 8% additions. Results showed that (S2) 5% ratio was slightly more acceptable than (S3) 8% ratio, but in general both ratios were remarkably acceptable. These results imply that adding spirulina to various food products can enhance their overall quality in addition to increasing their nutritional worth. Because they are precursors to other significant bioactive chemicals, phenolic compounds are especially needed in industry (El Shafai and Abdallah, 2023). Agree with (Uribe-Wandurraga *et al*., 2021; Luo *et al*., 2024) Integrating spirulina into kiwi jams amplifies their nutritional value, offering a high concentration of vitamins, minerals, and antioxidants that are retained through optimized processing. This combination aligns with consumer desires for nutritious and functional foods without sacrificing taste.

Conclusion:

Kiwi is a fruit with high nutritional value, but many people limit their use to eating it fresh directly or decorating desserts, and they do not pay attention to using it in the form of jam so that it is easy to eat everywhere after fortified with Spirulina algae, a nutrient-rich microalga, is recognized by the FDA as Generally Recognized as Safe. Adding spirulina algae to food items like jam

may result in many nutritional advantages such as antioxidant properties, high protein content where it contains the nine necessary amino acids, healthy fat, vitamins, minerals and other bioactive components and Fortifying jam in diets for have the ability to reduced many diseases and , improved healthy profiles, More investigation is required to ascertain the ideal concentration of spirulina in various food products for best nutritional advantages as well as to examine the long-term impacts of consuming spirulina-enriched products.

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إنتاج مربى الكيوي الغنية بالبروتين باستخدام طحالب السبيرولينا

إعداد

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مستخلص البحث:

تهدف هذه الدراسة تقييم تأثير إضافة مستويات مختلفة من طحالب السبيرولينا لإنتاج مربى فاكهة الكيوي الغني بالبروتين كأغذية وظيفية لتحسين وظائف الجسم وتوفير الفوائد الصحية والتوازن الغذائي نتيجة خلطها. تم تحضير ثلاث عينات من مربى الكيوي الاولي العينة الضابطة (S1) والثانية مربى الكيوي المدعم بطحالب السبيرولينا 5٪ (S2) والثالثة مربى الكيوي المدعم بطحالب السبيرولينا 8٪ .(S3).

عن طريق استبدال محتوى السكر .حيث تم تحليل عينات مربى الكيوي للرطوبة والرماد والبروتين والدهون والألياف والكربوهيدرات في العينات S1 و S2 و S3 و ظهر التركيب التقريبي لمربى الكيوي S3 و S2 زيادة كبيرة في محتوى العناصر الغذائية الألياف والرماد والبروتين والدهون لإضافة طحالب السبيرولينا مع الكيوي مقارنة بالعينة الضابطة، ولأن مربي الكيوي الكنترول مصدر غني بالكربوهيدرات بينما فقير في البروتين والعناصر الغذائية الأخرى وعند اضافة الطحالب إلى مربى الكيوي يؤدي إلى زيادة محتوها من البروتين S2 = 4.34±0.06؛ S3 = 6.48±0.32 مقارنة بالعينة الكنترول 0 ±1.18.

بالإضافة إلى احتواء الطحالب على جميع الأحماض الأمينية الأساسية، مما يجعل مربى الكيوي المدعم مصدرًا متكاملًا للبروتين من حيث الجودة والقيمة الغذائية.واثبتت نتائج الخصائص الحسية لمنتجات مربى الكيوي المدعمة بالسبيرولينا زيادة في الخصائص الحسية مقارنةً بمربى الكيوي الكنترول .وتوصي الدراسة بضرورة تناول الأطعمة الوظيفية المدعمة بالسبيرولينا، فهي مصدر جيد للبروتين ومركبات غذائية أخرى، وتُعتبر غذاءً وظيفيً نظرًا لقيمتها الصحية والغذائية العالية ومحتواها العالي من البروتين والألياف الغذائية. وحيث شعبيتها ازدادت في العقود الأخيرة وخاصة مع الاطفال والمراهقيين مما يتطلب مزيدًا من الدراسة في هذا الصدد

الكلمات الدالة : طحالب السبيرولينا ، الأغذية الوظيفية، فاكهة الكيوي، مضادات الأكسدة، مربى غنية بالبروتين.