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EFFECT OF KIWI FRUIT IN MILK COAGULATION: A MINI-REVIEW

[1]Dr. Shubhangi Nigam, [2]Radhika Bhatia, [3]Siddharth Singh, [4]Mayur Kant Singh

[1]Assistant Professor, [2]Student, [3]Student, [4]Student
[1]Department of Food Engineering and Technology, Institute of Engineering and Technology
[1]Bundelkhand University, Jhansi, Uttar Pradesh, India

***Abstract*:** It is well known that acids are used for the coagulation of milk. In the past few years, many kinds of research have been conducted to determine the effects of kiwi fruit on milk coagulation. Kiwi contains the clotting enzyme actinidin which exhibits a high level of milk clotting activity. Some parameters such as moisture, and yield decreased with coagulation however, protein and fat content increased slightly by 2-3% and parameters like ash and pH have shown no change after the coagulation of kiwi. The citric acid present in the kiwi fruit produces milk products with the most desirable characteristics and displays chymosin-like properties.

***IndexTerms* - Kiwi, milk, coagulation, clotting.**

I. INTRODUCTION

Fruits play a crucial part in our day-to-day life. They are stuffed with high nutritive values along with a wide variety of flavors. Fruits also play an important part in our health and medical assistance. Kiwi has gained a humongous amount of popularity in the last two decades. (Tyagi et al., 2015). It is a type of gooseberry which is native to northern China. Kiwifruit quickly progressed and man-altered wildlife that had only been slightly misused by man into a marketable commodity of foreign trade relevance in the 20th century.

The genus of kiwifruit is Actinidia and the family Actinidiaceae. Macaque peach, Mihoutau, and Chinese gooseberry are some of the other names for kiwi fruit (Tyagi et al., 2015). There are 76 species in the genus Actinidia, but only two of them are commercially grown: Actinidia chinensis (golden kiwifruit) and Actinidia deliciosa (fuzzy kiwifruit), Actinidia polygama (silver kiwifruit), Actinidia melanandra (red kiwifruit), Actinidia purpurea (purple kiwifruit), Actinidia arguta (baby kiwifruit), Actinidia kolomikta (arctic kiwifruit), and Actinidia arguta (baby kiwifruit) are some of the other Actinidia species (Satpal et al., 2021).

China leads all countries in kiwi production, followed by Italy and New Zealand. Italy and New Zealand are the world's two largest kiwi exporters (Satpal et al., 2021).

Kiwi is approximately 3 inches oval-shaped fruit with green flesh, white pulp, and brown hairy peel. The plant flourishes either in full sunlight or light shade, and the kiwi plant prefers slightly acidic soil with a pH between 6.0 and 6.5. Kiwi is predominantly consumed fresh, yet it is processed into juices, purees, candies, fortified drinks, dehydrated, frozen, and syrups (Satpal et al., 2021). Kiwifruit is exceptionally high in vitamin C and contains a variety of other nutrients, such as folate, potassium, dietary fiber, and vitamin E levels that are nutritious significant, as well as a variety of bioactive constituents, as well as a diverse array of antioxidants, phytonutrients, and enzymes which provide functional and metabolic gains.

It exhibits properties like antioxidative, anti-inflammatory, and antimicrobial which prevent or help in the treatment of many chronic diseases. Kiwi has a pH of 3.1-3.9 making it a high acid fruit. It contains cysteine proteases actinidin which exhibits a high level of milk clotting activity (Puglisi et al., 2014).

II. Chemistry of Kiwi Fruit

Researchers used metabolomics and transcriptomics to identify dynamic changes in 285 metabolites in kiwifruit during the growth of tetraploid yellow flesh kiwi (Xiong et al., 2020). Among the 285 metabolites, there are 19 carbohydrates, 99 organic acids, and derivatives, 86 amino acids and derivatives, 69 lipids, and 12 vitamins and derivatives (Xiong et al., 2020). The moisture content of various kiwifruit types has exceeded 80%.

Starch- Starch is important in the development of kiwis to the ripening stage which is suitable for eating. The total starch content (TSC) of kiwifruit varied with cultivators and was also affected by storage maturity (Li & Zhu, 2018). Kiwifruit flours had a lower TSC than that potato, maize, and wheat flours (65 %, 84%, and 77%, respectively) (Li & Zhu, 2017). The X-ray diffraction pattern of kiwi starch is of B-type. Flattened and spheroid in shape, the starch granules of kiwi are of the size of 4-10μm. The physiochemical parameters and composition of A. Chinensis starches were amylose leaching, swelling power, water solubility index, and rheology. Kiwifruit starches had higher enthalpy change for gelatinization and yield stresses than other starch-rich products such as potato and maize starch, but their rheological properties are like that of potato (Li & Zhu, 2017).
Amino Acids- Glutamic and aspartic acids, arginine, leucine, lysine, glycine, valine, alanine, serine, isoleucine, threonine, phenylalanine, cysteine, histidine, methionine, tryptophan, proline, and tyrosine were the 18 amino acids found in kiwifruit with varying level (Pérez-burillo et al., 2018).
Lipids- Pulp lipids were highly unsaturated, with total saturated fatty acids. Kiwi seeds contain a high concentration of unsaturated fatty acids (Wang et al., 2020).
Mineral- Potassium, phosphorus, calcium, magnesium, sodium, iron, copper, zinc, manganese, and selenium with variable concentrations are present (Wang et al., 2020).
Vitamins- Vitamin C is the most abundant vitamin present in the kiwi fruit (Wang et al., 2020). Other vitamins present in kiwi are A, β-carotene, folate, tocopherol, lutein, zeaxanthin, riboflavin, niacin, and pantothenic acid, vitamin B6, vitamin E, vitamin K, and choline (He et al., 2019)**.** Vitamin D promotes active Ca uptake in the human body and is also involved in the transport of protein expression. Magnesium absorption has been observed to occur passively in the small intestine (Satpal et al., 2021).

III. 3. Methodology of Paneer

3.1 Sample Collection

The Actinidia deliciosa (fuzzy kiwifruit) was obtained from Jhansi, Uttar Pradesh. Good quality kiwi was selected. Mixer Grinder, Heating Mantle, Laboratory Thermometer, plastic bowls, muslin cloth, thermometer, stirrer, beaker, conical flask, test tubes, petri dish, knife, and spatula were gotten from the Food Processing Laboratory of the department of food engineering and technology, Bundelkhand University, Jhansi. Also, milk (full cream and double tonned), honey, black salt, table salt, cinnamon, and cardamom were purchased from a retail shop in Jhansi.

3.2 Preparation of Kiwi Syrup

Firstly, 4 kiwis were taken. Then peeled and chopped with a knife. The chopped kiwi is then placed in the mixer grinder. The kiwi juice was poured into a beaker. Honey 10ml, cinnamon 4g, black salt 4g, and table salt 3g were added to the kiwi juice. Now, the obtained liquid is our kiwi syrup. Below Fig. shows the flow chart for the preparation of kiwi syrup.

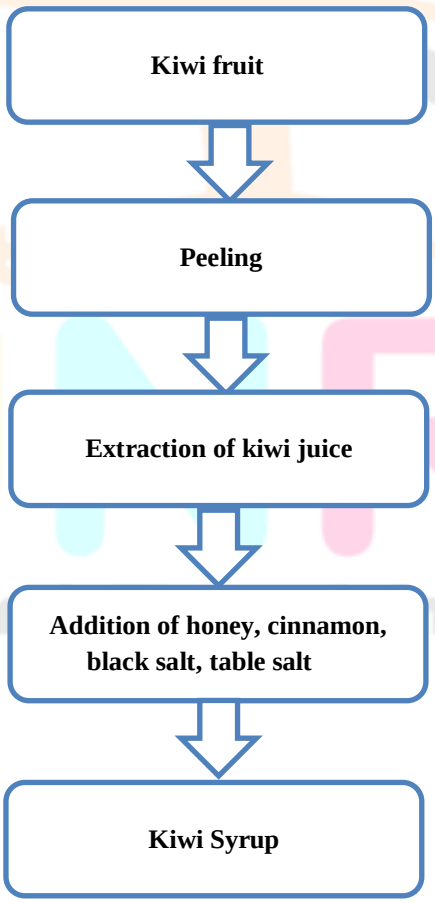

Fig 1: Production of Kiwi Syrup

Kiwi juice is used as a coagulating agent in milk coagulation. Seeds were not removed, as seeds will give a crunchy texture and mouthfeel. Honey is added to decrease the sourness caused by acid coagulation as kiwi is an acidic fruit. The addition of cinnamon, black salt, and table salt is for additional flavor.

3.3 Preparation of Paneer

Firstly, a combination of Double tonned and Full cream milk was taken for making flavored paneer. After this, heat the milk to 90°C, and during this process, cardamon was added to enhance the flavor. Wait for a few minutes so that the temperature reaches 75°C and when it reaches the desired temperature, add the kiwi syrup that we made above, and stir it so that syrup is mixed up thoroughly in the milk. After cooling the mixture up to room temperature, filtered it with a muslin cloth. Now, squeeze the unsettled paneer and then placed it below the heavy object for up to 1hr.

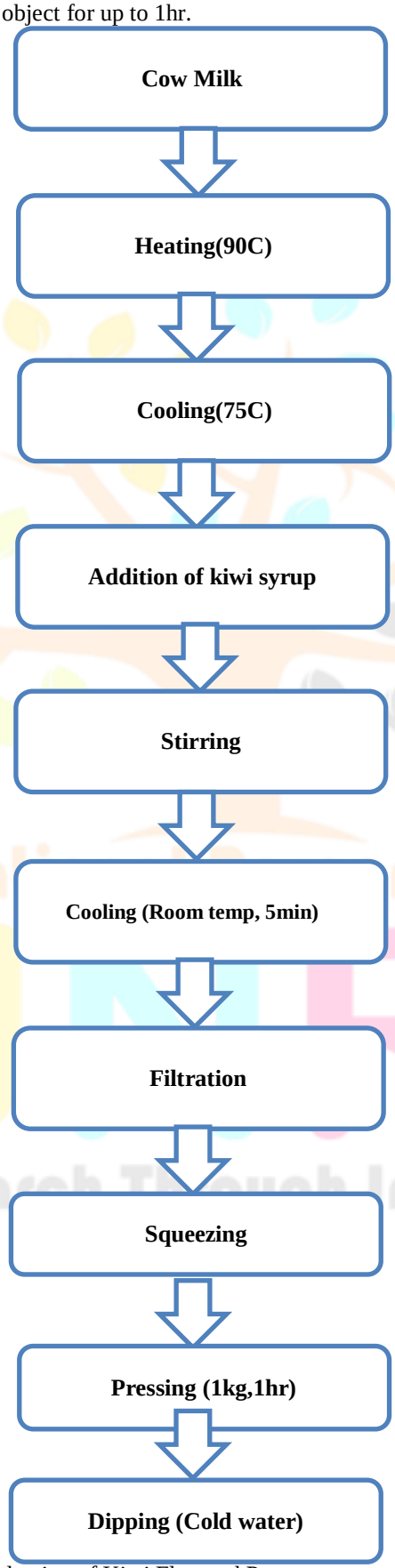

Fig2: Production of Kiwi Flavored Paneer

The milk is heated to provide heat treatment. By heating, the temperature increases which will help in the coagulation of milk. Cardamon gives the best flavor when added during the process of boiling. The prepared kiwi syrup is added after cooling the boiled milk till it reaches 75°C. By cooling, the now decreased temperature will help in the smooth texture of the paneer. With the addition of kiwi syrup, the coagulation will proceed and the change in the composition of milk will be seen around 5 min. Constant stirring after the addition of kiwi syrup is important for proper mixing of syrup with the milk and proper coagulation. When the coagulation starts, leave the mixture for cooling. After completion of coagulation, use a muslin cloth to filter the solid product. The solid matter is squeezed to remove excess water. Place the unsettled paneer under a heavy object for a maximum of 1 hour to get its desired shape and texture.

3.4 Storage Condition for Paneer

Even though the paneer gets its shape and texture at around 1hr, it should still be kept for another 2hrs at least at 5°C. Afterward, the paneer is ready for sensory evaluation. The paneer should be kept in some small amount of water, to ensure no loss of moisture.

IV. 4. Nutritional Qualities of Kiwi

The kiwifruit has a higher commercial and economic value due to its high pulp juices, delicious taste, thick flesh, and high nutritional value (He et al., 2019). The components of fruit have been studied primarily in terms of its nutritional components, which include protein, lipids, carbohydrates, vitamins (vitamins A, C, and E, as well as folic acid), minerals, polyphenols, antioxidants, and dietary fiber (Richardson et al., 2018). Kiwifruit has a higher vitamin C content than lemon, orange, strawberry, and grapefruit (He et al., 2019). Kiwifruit is high in phytonutrients and well-known vitamins and minerals, all of which are beneficial to one's health. It has a high concentration of fructose and glucose, with a trace of sucrose. The high ascorbic acid content and low tannin content of kiwifruit are the reasons why the cut fruit does not show a browning reaction like most other fruits. Kiwifruit consumption raises plasma vitamin E levels since the vitamin E in it is bioavailable. In kiwifruit, nearly all the dietary fiber in the fruit is found in its cell walls, particularly the polysaccharides. Caffeic acid and other chlorogenic derivatives, syringic acid, ferulic acid, gallic acid, salicylic acid, protocatechuic acid, quercetin, glycosides, coumaric acid, and procyanidins are among the various bioactive polyphenols found in kiwi (Wang et al., 2020). Certain factors including concentration, health status, excretory losses, drug-nutrient interaction, and nutrient-nutrient attraction influence the bioavailability of vitamins and minerals in the human body. Although its flesh contains remarkably low oxalates and tannic acid levels, studies have shown that kiwi has no significant antinutritive activity whatsoever (Wolber et al., 2013).

Table 1: Nutritional Qualities of Kiwifruit per 100g (Richardson et al., 2018), (Satpal et al., 2021), (HUANG et al., 1990)

Nutrient	Green kiwifruit
Water (g)	83.1
Energy (kcal)	61
Protein (g)	1.14
Fat (g)	0.52
Ash (g)	0.61
Carbohydrate (g)	14.7
Fiber (g)	3

V. Health Benefits of Kiwi

5.1 Digestion

The proteolytic enzyme actinidin is abundant in kiwifruit. It is a protein-dissolving enzyme, that improves protein digestion, can aid digestion, and positively influences protein digestion in the stomach and intestine (Tyagi et al., 2015). It smoothly aids the passage of food through the digestive system. It has laxative properties that aid in the treatment of constipation. The oxalates present in kiwi are the only allergenic factor. In some individuals, oxalates can irritate the oral mucosa. Because of the high concentration of oxalate, kiwi should be avoided by patients with nephrolithiasis and urolithiasis (Satpal et al., 2021).

5.2 Skin

The presence of an essential nutrient like vitamin C acts as an antioxidant in our bodies to help prevent damage from pollution, UV radiation, and smoke along with smoothening wrinkles, keeping skin young and vibrant, and improving overall skin texture Kiwi is also rich in vitamin E that protects skin degradation by keeping it soft and moist. Vitamin C is also important for the activation

of collagen, a connective protein that restores and maintains the skin's firmness and suppleness. Vitamins also aid in cell regeneration, making the skin appear better and more flexible than usual (Tyagi et al., 2015).

5.3 Heart & Cardiovascular
Potassium and fiber present in kiwi is the main supporting unit of heart health. Fibre reduces the high cholesterol level, which reduces the risk of heart disease and heart attack. With increased intake of potassium and decreased intake of sodium can reduce the risk of cardiovascular diseases. It has inhibitory properties that help to lower triglyceride levels in the blood (Tyagi et al., 2015). Kiwi has shown to be effective in the maintenance of heart health due to the presence of polyphenols and antioxidants in high content. In smokers, it regulates blood pressure and platelet aggregation. It lowers systolic and diastolic blood pressure by 10mm and 9 mm Hg, respectively (Satpal et al., 2021).

5.4 Cancer
Kiwi is a cytotoxic substance that kills cancer cells while leaving healthy cells alone. Kiwi contains an antimutagenic component that facilitates the prevention of gene mutations that can lead to cancer. Catechin, a phytochemical found in kiwi, helps in the reduction of toxicity of anti-cancer agents by stimulating bone marrow proliferation. The dietary fiber in kiwi fruit helps to reduce the risk of colon cancer. Kiwi's biochemical composition includes a plethora of antioxidants, carotenoids, vitamins, and fibers that have been effective in cancer prevention and healing (Tyagi et al., 2015).

5.5 Diabetes
Having a low glycemic index, kiwi is an excellent choice for diabetic patients. Fibre-rich kiwi keeps the blood sugar level under control for diabetic patients (Tyagi et al., 2015). This fruit is suitable for curring Type-2 diabetes (Satpal et al., 2021).

VI. Pharmacological Qualities of Kiwi
Kiwi has a variety of bioactive compounds with natural pharmacological properties, such as anti-HIV, anti-diabetic, cytotoxic, anti-tumor anti-inflammatory, anti-hypertensive, anti-carcinogenic, antifungal, antiviral, anti-asthmatic, anti-microbial, anti-constipation, and antioxidant properties.

6.1 Anti-Tumor Properties
Kiwi Fractions, crude obtains, and isolated compounds have been found to inhibit tumor growth in different human cancer cells. Antitumor properties that are consistent with the traditional use of kiwis, such as colon cancer, esophageal cancer, gastric cancer, liver cancer, and lung cancer. Many triterpenoids with carboxyl groups in the roots exhibit cytotoxicity against various types of cancer cells (He et al., 2019).

6.2 Antioxidant Properties
Polyphenols, flavonoids, unsaturated fatty acids, and vitamin C are effective antioxidants in kiwifruit. The presence of a high level of vitamin C was attributed to the kiwi's antioxidant activity, and the antioxidant activity was primarily attributed to the presence of many phenolic substances (He et al., 2019).

6.3 Anti-Inflammatory Properties
Polyphenols from kiwi seeds are primarily composed of caffeic acid, ferulic acid, p-coumaric acid, p-hydroxybenzoic acid, and protocatechuic acid at the cellular level. The fruit juice showed anti-inflammatory activity in patients with type 2 diabetes mellitus. As an outcome, the anti-inflammatory potential of kiwi seeds is primarily dependent on the synergistic effect of these polyphenolic compounds and could be used to help prevent a wide range of inflammatory diseases (He et al., 2019).

VII. Conclusion
Because kiwi fruit is not available all year, therefore attempts should be made in the development of kiwi-based processed foods. Its processing and preservation can be used as a weapon to enhance employment opportunities and nutritional qualities of kiwi-based products.

The addition of kiwi for coagulation is a slow process. As kiwi is used as a milk coagulating agent, the acids present in the fruit will coagulate the milk, and clotting will take place. The result of this clotting will lead to different types of products: liquid and solid products. The solid product obtained can be used in the making of other products such as paneer, curd, and cheese, with or without the use of microbial cultures. Also, the liquid obtained can be used for further processing.
The moisture content of the paneer decreased due to low citric acid content, which results in higher H+ ions also due to low pKa value. The protein content of the paneer increased due to low moisture content, which made the paneer easily recover the milk solids. As the solids in the paneer are bound properly to make a network, which entraps fat efficiently. Kiwi increased the fat content along with fat recovery (Mazorra-Manzano et al., 2013). The time for the formation of the paneer was 25-30min. Change in physicochemical properties of milk after coagulating with kiwi:

Moisture: 58.4±0.54
Fat (g/100g): 18.3±0.29
Protein (g/100g): 17.6±0.27
Total Solid Recovery: 57.5±031
Fat recovery: 93.1±0.56
Protein recovery: 91.6±051
Yield: 131.2±1.27 (Mazorra-Manzano et al., 2013).

The physicochemical properties of paneer have improved with the use of kiwi as a coagulant. The moisture content also decreased in comparison to the regular paneer available in the market, which will lead to an increase in the shelf life of these products.
It can be easily concluded that kiwi can be used as coagulation for the manufacturing of products like paneer for kiwi has good total solids recovery, yield, and most desirable sensory characteristics.
Also, the incorporation of kiwi improved the sensory quality (flavor, color, appearance, texture) of paneer while maintaining quality and overall acceptability. The incorporation of kiwi will be beneficial for health-conscious consumers and result in the development of new varieties of dairy products in the market.

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