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B. Khamitova[1]*, A. Taspoltayeva[1], G. Kozhabekova[1], S. Tokayev[2], B. Iskakov[2]
[1]M. Auezov' South-Kazakhstan University,
160012, Republic of Kazakhstan, Shymkent, Tauke Khan Ave.,5
[2]S. Seifullin Kazakh Agro Technical Research University,
010011, Republic of Kazakhstan, Astana, Zhenis avenue, 62
*e-mail: barno-007@mail.ru

THE USE OF FRUIT AND BERRY FILLERS IN THE PRODUCTION OF FERMENTED MILK PRODUCTS

Annotation: *The article discusses the possibility of using fruit and berry fillers in the production of fermented milk products. To increase the nutritional value and functional properties of yoghurts, various fillers and additives are introduced into their composition, especially those that enhance their therapeutic and prophylactic effect. The use of food additives and fillers rich in dietary fiber, which are pectins, microcrystalline cellulose, vegetable gums, vegetable and fruit and berry additives, allows you to give yoghurts additional functional properties. The purpose of the research was to study the features of using domestic natural fruit and berry fillers for the production of yoghurts and curd products. To assess the effective use of fillers, the nutritional value and chemical properties, stability of color, taste and consistency of the dairy product were studied. Organoleptic indicators, physicochemical indicators and energy value of yoghurt with fruit and berry fillers were studied. The developed yogurt with fruit and berry filling is characterized by reduced energy value (77.3 kcal), good organoleptic indicators, which is explained by the introduction of a plant component.*

Key words: *milk product, yogurt, vegetable filler, berry mix, food value, milk, fruit-berry, thermostat technology.*

INTRODUCTION

In recent decades, food industry specialists have been faced with the urgent task of expanding the range of fortified foods for mass consumption. Currently, consumers tend to purchase products that prevent diseases and metabolic disorders caused by negative environmental influences. Among the huge variety of products of animal and plant origin, milk and dairy products are the most nutritionally and biologically valuable, the value of which is determined by the rich and balanced composition of its components and the high digestibility of all nutrients [1].

Traditions of consumption of fermented milk products, actively promoted at present «healthy nutrition» provide a stable demand on the market for such products, in particular - for yoghurts. The range of products is constantly expanding, new types of yoghurt with different levels of acidity, viscosity, various flavors and biologically active additives are being developed. Requirements for packaging are also changing.

Milk and dairy products, including yoghurts, are mass-market products that often contain plant-based additives that increase their nutritional and biological value.

The history of yogurt is long, and legend has it that ancient Turks invented yoghurts in order to set up their guardian angels in a peaceful way. They called this delicious and healthy product "white oxygen." However, another version is the most realistic. According to it, the precursor of yogurt appeared in those distant times when ancient nomadic peoples traveled transporting milk in goatskin skins. Bacteria got into the milk from the air, and the movement of the animals caused the milk in the skins on their backs to constantly mix and ferment in the heat, turning into a special product that was the forerunner of modern yogurt [2].

This is explained, among other things, by current trends in the food industry, reflected in the development of technologies and production of healthy food products [3]. Valuable suppliers of fillers that significantly increase the nutritional and biological value of dairy products are local berry crops growing in Kazakhstan, for example, cherries and strawberries. In addition, it is relevant to study and introduce into the recipe ingredients with functional properties. The current issue is the development of vitamin-rich fermented milk products, especially yogurts, because this fermented milk product is in great demand among all age groups of the population, especially children.

It is known that the human body during childhood and adolescence is especially in need of balanced, fortified nutrition, so it is very important to use vitamin and multivitamin supplements in yogurt production technology [4].

There are quite a lot of works in the field of production of yoghurts enriched with plant ingredients and biologically active additives. However, expansion of their range is possible due to introduction of new generation food fortifiers based on enzymatic meals, which exhibit antioxidant, antitoxic, immunomodulatory and radioprotective properties [5, 6].

The use of food fortifiers in the production of yoghurts has been little studied. However, the prospects and feasibility of their use in obtaining fortified yoghurts with a high content of biologically active substances have been shown.

The aim of the work is to develop and evaluate the quality and competitiveness indicators of new types of yoghurts fortified with plant ingredients, taking into account their demand in the consumer market of Kazakhstan.

Milk, as a raw material for yoghurts, is a source of biologically active substances [7]. Yogurt is a fermented milk product with an increased content of dry skim milk solids, produced using a mixture of starter microorganisms - thermophilic lactic streptococci and Bulgarian lactobacillus [8].

To increase the nutritional value and functional properties of yoghurts, various fillers and additives are introduced into their composition, especially those that enhance their therapeutic and prophylactic effect. The use of food additives and fillers rich in dietary fiber, which are pectins, microcrystalline cellulose, plant gums, vegetable and fruit additives, make it possible to impart additional functional properties to yoghurts [9].

Such a variety of plant materials used in the production of yoghurts indicates broad opportunities for creating a wide range of them, a balanced composition, as well as products with functional target purposes. The food ingredients industry has opened up virtually unlimited opportunities for manufacturers of dairy products with new consumer properties - nutritional value, balance of constituent elements, taste, smell, consistency, shelf life, medicinal and dietary indicators [10].

Fruits and berries are sources of glucose and fructose, vitamins, minerals, phenolic compounds, and dietary fiber. Vegetables are rich in vitamins, minerals, nitrogen compounds, and dietary fiber. Taking into account compatibility with milk, pumpkin, carrots, spinach, peas, and cabbage are considered the most acceptable. To give yoghurts a distinct taste and smell of fruits and berries, vegetables, and to give them an attractive appearance, fruit, berry, and vegetable additives in the form of syrups, concentrates, or dry mixes are used. These fillers regulate the content of vitamins, carbohydrates, and minerals in fermented milk products. Dietary fiber plays a special role in the formation of functional properties [11, 12].

EXPERIMENTAL METHODS

The determination of safety and quality indicators of raw materials, processed plant raw materials (semi-finished plant products) and finished yoghurts was carried out in accordance with the current regulatory documentation. Drinking yoghurt was chosen as the object of the study as one of the most popular fermented milk products. Prunes and peaches were used for its enrichment, the berry mix consists of raspberries, strawberries, lingonberries, rose hips, and hawthorn. The chemical composition of the above berries was studied. To establish the ratio of components and develop a recipe, studies of the organoleptic and physicochemical indicators of the test samples were carried out.

The proposed lactic acid product - yogurt production technology is developed as follows. Fruit yogurt is produced according to the general scheme of conventional kefir technology. The fruit supplements are pumped into the tank together with kefir, mixed well and left for further ripening at a temperature of 8-10oC for 1-2 hours. Mass fraction of sucrose in yogurt is not less than 5%. Fruit yogurt and added additives have a characteristic taste and aroma.

The thermostatic method of production of yogurt with fruit consists of the following operations: receiving and sorting milk, standardizing and purifying milk, homogenizing milk, pasteurizing milk, cooling milk, adding yeast, adding fruit supplement, fermentation, cooling, ripening, packaging and save.

As vegetable additives – fruit fillers include prunes, peaches, and berry fillers include strawberry, cranberry, raspberry, rosehip, and hawthorn. Hawthorn fruits belong to a universal therapeutic dietary product, they have a good effect on the human body.

Physicochemical methods for accounting for the chemical composition of fruit and berry fillers, analysis of the composition of biologically active substances of fruits and berries, determination of physicochemical indicators (refractometry, pH-metry, titration, spectrophotometry, viscometry, atomic absorption spectrometry, gas chromatography). These methods are based on the requirements of the general standard [14], the methodology for evaluating the organoleptic characteristics of whey (color, aroma, taste and consistency) using organoleptic and physicochemical methods was carried out in accordance with the requirements of GOST 31981-2013 «Yoghurts. General specifications» [16].

RESEARCH RESULTS AND DISCUSSION

The chemical composition of the liquid is different depending on the principle and degree of its effect on the body. Aromatic liquid is widely used for medical purposes, from household purposes, because in most cases it contains biologically active substances, ephip ointment, and aromatic components. It is defined as a large volume and a positive effect on the body [13, 15].

In the process of choosing raw materials for the production of plant extracts, we came out of the real specificity of the chemical composition of fruit-bearing raw materials. Studies have shown that there is a difference between the chemical composition of fruit and Berry raw materials [14]. Hawthorn and rosehip differ from rosehip in that they have less mash (about 78%), more clechatka (9.3 and 8.4%, respectively), which affects the yield in the process of their mechanical processing. With all berries, fruits are a source of valuable vitamins (C – up to 57.0 mg/100g), dubile (1.24-5.8%) substances. The content of organic substances in fruits and berries ranges from 1.7% (rose hips) to 3.5% (lemongrass). After squeezing fruits and berries, the remaining mash contains a sufficient amount of biologically valuable substances, which can be obtained by extraction. We further studied three types of raw materials (rosehip, raspberries, strawberries, cranberries) and Hawthorn, rosehip syrups.

The chemical composition of fruit fillings as a functional ingredient of yogurt is presented in Table 1 [14].

Table 1 – Nutritional value of fruit fillings per 100 grams

Indicators	Proteins, g	Fats, g	Carbohydrates, g	Ash, g	Water, g	Calorie value, kCal
Prunes	2.18	0.38	56.78	2.64	30.92	240.0
Peach	0.91	0.25	9.54	0.43	88.87	45.0
Strawberries	0.8	0.4	7.5	2.2	87.4	41.0
Cranberries	0.4	0.1	12.2	0.2	87.1	46.0
Raspberries	1.2	0.6	11.9	0.5	85.8	52.2
Rose hip	1.6	0.7	22.4	0.33	54.0	109.0
Hawthorn	1.12	0.01	14.2	2.73	72.0	62.2

The amount of microelements in fruits and berries is given in Table 2.

Table 2 – Amount of trace elements in fruits and vegetables

Refined raw material	Amount of mineral properties, mg						
	Na	K	Ca	P	Fe	Al	Mg
Prunes	2.0	732.0	43.0	69.0	0.93	-	41.0
Peach	30.0	363.3	20.0	34.2	0.6	-	16.0
Strawberries	18.0	161.0	40.0	23.0	1.2	-	18.0
Cranberries	89.7	85.0	8.0	13.0	0.14	48.1	6.0
Raspberries	1.0	224.0	40.0	37.0	-	200.0	22.0
Rose hip	13.21	158.0	66.0	127.18	279.56	-	11.7
Hawthorn	29.0	1310.0	326.0	87.0	32.6	9.6	100.0

Therefore, the fruits selected on the basis of the pre-treatment can be used as plant fillers due to their chemical element content.

Factors that influenced the popularity of fermented milk drinks: organoleptic characteristics - pleasant taste due to various fruit mixtures, pleasant consistency; healing properties - has a positive effect on human health; the possibility of modification - the composition of drinks can be changed depending on demand and taste; life extension - the presence of microorganisms in fermented milk drinks that suppress harmful microflora; use of genetic engineering achievements in the production of fermented milk drinks - yogurt based on new and traditional technologies.

Organoleptic indicators of yogurt were determined at 18±20C according to the standard. Organoleptic indicators of the finished product are shown in table 3.

Table 3 – Organoleptic indicators of yogurt

Indicators	Characteristic of the indicator
Taste	Pure lactic acid, with a characteristic flavor of the supplement, faintly sweetened.
Smell	Has a pleasant, lactic acid herbal supplement smell
Color	Light pink
Consistency	Gentle, homogeneous liquid, easy to apply.

In terms of physical and chemical parameters, pumpkin nectar must meet the requirements established in the standard [16]. Physico-chemical indicators of yogurt with fruit supplements are shown in table 4.

Table 4 – Physico-chemical properties of fruit yogurt

Raw material type	pH	Acidity, T^0	Density, kg/m^3	Proteins, %	Fats, %	Carbohydrates, %	Ash, %	Dry stuff, %	Energy value in 100 g of product, kcal
Fruit yogurt	4.55	84.4	1020.0	2.7	2.5	11.0	0.6	17.0	77.3

The quality of fruit and berry yoghurt in terms of organoleptic and physicochemical indicators meets the requirements of GOST 31981-2013. No defects were found in the yoghurts, which indicates the use of high-quality raw materials and starter cultures in production (table 5).

Table 5 – Fruit yogurt 2.5% fat recipe (without cost per 1000 kg of product)

Raw material	Recipe number		
	1	2	3
Natural milk 2.5% fat, kg	684.40	684.40	678.0
Skimmed milk, kg	145.24	145.24	102.0
Cranberry tray, kg	120.00	–	–
Strawberries, cranberries, raspberries, hawthorn, plums, kg	–	120.00	109.0
Natural peach paste, kg	–	–	130.0
Sugar, kg	–	–	–
Dry beetroot juice, kg	0.36	0.36	0.30
Fat-free milk starter, kg	50.00	50.00	50.00
Total, kg	1000	1000	1000

CONCLUSION

Thus, the technology and recipe of yogurt with fruit and berry fillings were developed in the work. The organoleptic indicators, physicochemical indicators and energy value of yogurt with fruit and berry fillings were studied. The developed yogurt with fruit and berry filling is characterized by reduced energy value (77.3 kcal), good organoleptic indicators, which is explained by the introduction of a plant component.

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Б.М. Хамитова[1]*, А.Р. Таспoлтаева[1], Г.А. Кожабекова[1], С.Д. Токаев[2], Б.М. Искаков[2]
[1]Южно-Казахстанский университет им. М. Аэзова,
160012, Республика Казахстан, г. Шымкент, пр. Тауке хана, 5
[2]Казахский агротехнический исследовательский университет имени С. Сейфуллина,
010011, Республика Казахстан, г. Астана, пр. Женис, 62
*e-mail: barno-007@mail.ru

ИСПОЛЬЗОВАНИЕ ФРУКТОВЫХ И ЯГОДНЫХ НАПОЛНИТЕЛЕЙ В ПРОИЗВОДСТВЕ КИСЛОМОЛОЧНЫХ ПРОДУКТОВ

В статье рассматривается возможность применения фруктово-ягодных наполнителей в производстве кисломолочных продуктов. Для повышения пищевой ценности и функциональных свойств йогуртов в их состав вводят различные наполнители и добавки, особенно те, которые повышают их лечебно-профилактическое действие. Использование пищевых добавок и наполнителей, богатых пищевыми волокнами, которыми являются пектины, микрокристаллическая целлюлоза, растительные камеди, овощные и плодово-ягодные добавки позволяют придать йогуртам дополнительные функциональные свойства. Целью исследований являлось изучение особенностей использования отечественных натуральных фруктово-ягодных наполнителей для производства йогуртов и творожных продуктов. Для оценки эффективного применения наполнителей были изучены пищевая ценность и химические свойства, стабильность окраски, вкуса и консистенции молочного продукта. Изучены органолептические показатели, физико-химические показатели и энерегетическая ценность йогурта с фруктово-ягодными наполнителями. Разработанный йогурт с фруктово-ягодным наполнителем характеризуется пониженной энерегтической ценностью (77,3 ккал), хорошими органолептическими показателями, что объясняется введением растительного компонента.

***Ключевые слова**: молочный продукт, йогурт, пищевой наполнитель, ягодная смесь, пищевая ценность, молоко, фрукты, термостатная технология.*

Б.М. Хамитова[1]*, А.Р. Таспoлтаева[1], Г.А. Кожабекова[1], С.Д. Токаев[2], Б.М. Искаков[2]
[1]М. Әузов атындағы Оңтүстік Қазақстан университеті,
160012, Қазақстан Республикасы, Шымкент қ., Тауке хан даңғылы, 5
[2]С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті,
010011, Қазақстан Республикасы, Астана қ., Жеңіс даңғылы, 62
*e-mail: barno-007@mail.ru

АШЫТЫЛҒАН СҮТ ӨНІМДЕРІН ӨНДІРУДЕ ЖЕМІС-ЖИДЕК ТОЛТЫРҒЫШТАРЫН ҚОЛДАНУ

Мақалада ашытылған сүт өнімдерін өндіруде жеміс-жидек толтырғыштарын пайдалану мүмкіндігі қарастырылады. Йогурттардың тағамдық құндылығы мен функционалдық қасиеттерін арттыру үшін олардың құрамына әртүрлі толтырғыштар мен қоспалар қосылады, әсіресе олардың емдік және профилактикалық әсерін күшейтеді. Пектиндер, микрокристалды целлюлоза, көкөніс сағыздары, көкөніс және жеміс қоспалары сияқты тағамдық талшықтарға бай тағамдық қоспалар мен толтырғыштарды қолдану йогурттарға қосымша функционалдық қасиеттер беруге мүмкіндік береді. Зерттеу жұмысының мақсаты йогурттар мен сүзбе өнімдерін өндіру үшін отандық табиғи жеміс-жидек толтырғыштарын пайдалану ерекшеліктерін зерттеу болды. Толтырғыштарды тиімді пайдалануды бағалау үшін сүт өнімдерінің тағамдық құндылығы мен химиялық қасиеттері, түсінің тұрақтылығы, дәмі мен консистенциясы зерттелді. Жеміс және жидек салмасы бар йогурттың органолептикалық қасиеттері, физикалық-химиялық қасиеттері және энергетикалық құндылығы зерттелді. Жеміс-жидек салмасы бар әзірленген йогурт төмендетілген энергетикалық құндылығымен (77,3 ккал), жақсы органолептикалық көрсеткіштермен сипатталады, бұл өсімдік компонентін енгізумен түсіндіріледі.

Түйін сөздер: *сүт өнімдері, йогурт, көкөніс толтырғышы, жидек қоспасы, тағамдық құндылығы, сүт, жеміс-жидек, термостат технологиясы.*

Сведения об авторах

Барна Махаматовна Хамитова* – кандидат технических наук, ассоциированный профессор; Южно-Казахстанский университет им. М.Ауэзова, Республика Казахстан, Шымкент; e-mail: barno-007@mail.ru. ORCID: https://orcid.org/0000-0001-8377-3938.

Айбала Рысбековна Тасполтаева – кандидат технических наук, доцент; Южно-Казахстанский университет им. М.Ауэзова, Республика Казахстан, Шымкент; e-mail: aibala.taspoltaeva.69@mail.ru. ORCID: https://orcid.org/0000-0002-0286-4721.

Гульдана Акбердиевна Кожабекова – магистр, старший преподаватель; Южно-Казахстанский университет им. М.Ауэзова, Республика Казахстан, Шымкент; e-mail: guldana20.14@mail.ru. ORCID: https://orcid.org/0009-0001-9776-2524.

Серик Дюсенгалиевич Токаев – к.т.н., старший преподаватель; Казахский агротехнический исследовательский университет имени С.Сейфуллина, 010011, Республика Казахстан, г. Астана; e-mail: tokaev_sd@mail.ru. ORCID: https://orcid.org/0000-0001-7927-8205.

Бауыржан Мырзабекович Искаков – PhD, преподаватель; Казахский агротехнический исследовательский университет имени С.Сейфуллина, Республика Казахстан, г. Астана; e-mail: baissemey@bk.ru. ORCID: https://orcid.org/0000-0002-7939-0210.

Information about the authors

Barna Khamitova* – Candidate of Technical Sciences, Associate Professor; M. Auezov South-Kazakhstan University, Republic of Kazakhstan, Shymkent; e-mail: barno-007@mail.ru. ORCID: https://orcid.org/0000-0001-8377-3938.

Aibala Taspoltayeva – Candidate of Technical Sciences, Associate Professor; M.Auezov South-Kazakhstan University, Republic of Kazakhstan, Shymkent; e-mail: aibala.taspoltaeva.69@mail.ru. ORCID: https://orcid.org/0000-0002-0286-4721.

Guldana Kozhabekova – Master, senior lecturer; M.Auezov South-Kazakhstan University, Republic of Kazakhstan, Shymkent; e-mail: guldana20.14@mail.ru. ORCID: https://orcid.org/0009-0001-9776-2524.

Serik Tokayev – Candidate of Technical Sciences, Senior lecturer; S.Seifullin Kazakh Agro Technical Research University, 010011, Republic of Kazakhstan, Astana; e-mail: tokaev_sd@mail.ru. ORCID: https://orcid.org/0000-0001-7927-8205.

Bauyrzhan Iskakov – PhD, lecturer; S.Seifullin Kazakh Agro Technical Research University, 010011, Republic of Kazakhstan, Astana; e-mail: baissemey@bk.ru. ORCID: https://orcid.org/0000-0002-7939-0210.

Авторлар туралы мәліметтер

Барна Махаматовна Хамитова* – **техника** ғылымдарының кандидаты, қауымдастырылған профессор; М. Әузов атындағы Оңтүстік-Қазақстан университеті, Қазақстан Республикасы, Шымкент; e-mail: barno-007@mail.ru. ORCID: https://orcid.org/0000-0001-8377-3938.

Айбала Рысбекқызы Тасполтаева – техника ғылымдарының кандидаты, доцент; М. Әузов атындағы Оңтүстік-Қазақстан университеті, Қазақстан Республикасы, Шымкент; e-mail: aibala.taspoltaeva.69@mail.ru. ORCID: https://orcid.org/0000-0002-0286-4721.

Гүлдана Ақбердиевна Қожабекова – магистр, аға оқытушы; М. Әузов атындағы Оңтүстік-Қазақстан университеті, Қазақстан Республикасы, Шымкент; e-mail: guldana20.14@mail.ru. ORCID: https://orcid.org/0009-0001-9776-2524.

Серик Дюсенгалиевич Токаев – т.ғ.к., аға оқытушы; С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Қазақстан Республикасы, Астана қ.; e-mail: tokaev_sd@mail.ru. ORCID: https://orcid.org/0000-0001-7927-8205.
Бауыржан Мырзабекович Искаков – PhD, оқытушы; С. Сейфуллин атындағы Қазақ агротехникалық зерттеу университеті, Қазақстан Республикасы, Астана қ.; e-mail: baissemey@bk.ru. ORCID: https://orcid.org/0000-0002-7939-0210.

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D.R. Orynbekov[1], Zh. Kalibekkyzy[1], A.N. Nurgazezova[1], G.N. Nurymkhan[1], Wu Gang[2], M. Muratkhan[1]*
[1]Shakarim University,
071412, Republic of Kazakhstan, Semey, Glinki str., 20 A
[2]Northwest A&F University,
712100, China, №.3 Taicheng Road, Yangling, Shaanxi
*e-mail: marat-muratkhan@mail.ru

DEVELOPMENT AND RSM-BASED OPTIMIZATION OF BIODEGRADABLE EDIBLE FILMS FROM ELECTRON BEAM-IRRADIATED STARCH AND CHITOSAN

Annotation: *This study aimed to develop and optimize edible antimicrobial films using electron beam-irradiated starches and biopolymer additives. Rice starch («Marzhan» variety) and cassava starch («Cassava 531» variety) were physically modified via irradiation at doses of 0, 3, 6, and 9 kGy using an ILU-10 accelerator. Film-forming solutions were prepared by blending starch, chitosan, and glycerol, followed by casting and drying. One-Factor-at-a-Time (OFAT) screening was conducted to evaluate the effects of starch content, gelatinization time, glycerol, and chitosan on film properties including tensile strength (TS), elongation at break (EAB), water vapor permeability (WVP), and transparency.*

A Box – Behnken Design (BBD) based on Response Surface Methodology (RSM) was used for multi-factor optimization. The regression model for transparency (%) revealed that starch and chitosan contents had positive linear effects but exhibited diminishing returns due to significant negative quadratic terms. Gelatinization time and glycerol content showed negative linear effects on transparency, while several interaction terms also influenced the response.

Although the model demonstrated modest statistical significance (R^2 = 35.05%), it highlighted complex factor interdependencies and provided direction for optimal formulation. The findings support the potential of irradiated starch in functional biodegradable films and offer a foundation for future development of sustainable packaging materials with improved physical and barrier properties.

Key words: *edible film; starch irradiation; chitosan; biodegradable packaging; transparency optimization; response surface methodology (RSM); Box – Behnken design.*

Introduction

In recent years, the development of biodegradable and edible films has gained increasing attention as a sustainable alternative to conventional plastic packaging. These bio-based materials are derived from renewable resources and offer the added advantage of environmental compatibility, biodegradability, and in some cases, functional properties such as antimicrobial activity or antioxidant capacity. Among various biopolymers investigated, starch has emerged as a particularly promising film-forming agent due to its abundance, cost-effectiveness, film transparency, and biodegradability.

However, native starch-based films often suffer from several limitations, including poor mechanical strength, high water vapor permeability, and low flexibility, which restrict their broader industrial applications. To overcome these drawbacks, chemical, physical, or enzymatic modifications of starch have been proposed. In particular, irradiation-induced modification using electron beam technology has proven effective in altering the structural and physicochemical properties of starch, such as molecular weight, crystallinity, and gelatinization behavior, thereby enhancing its suitability for film formation.