The physical properties, which include dimensional, gravimetric, and frictional properties of broken and head rice kernels of variety PUSA 1121 were studied. Dry, semidry, and wet grinding methods were employed to grind the broken, and the chemical analysis was done for all three types of flours. Adsorption isotherm was studied at 20, 30, and 40°C. Pasting and powder rheology was studied at various moisture levels. Thermal properties (thermal conductivity, thermal diffusivity, and specific heat) of flours were studied as a function of moisture content. Various prediction models were used to compare the value of thermal conductivity obtained through the experimental method. The specific heat was also compared with the values obtained from the prediction model and the error found was mere minimum.

Misha M R
Kamlesh Prasad

Studies on the Selected Engineering Properties of Basmati Rice Flour

The corresponding author is Professor and Head, Department, Food Engineering & Technology, Sant Longowal Institute of Engineering & Technology, Longowal. His specialization is in Fruits and vegetable processing.

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Banana Starch

Banana starch was isolated, purified, and characterized from plantain and dessert green banana cultivars. The Grand Naine banana is commonly used as a ripened banana for table purposes in India. Banana has to be transported in green unripe form from its cultivation center to various destinations in India mainly through a surface transport system. The banana has to face harsh conditions during surface transportation, loading, and unloading. The associated quantitative losses were observed to be around 30%. The edible portion recovered from those bananas was around 35%. Out of the edible portion, starch could be extracted to about 11% using the wet extraction method. Considering the above problem of huge losses occurred for dessert banana the modification of Grand Naine banana starch was carried out through two different physical procedures such as pre-gelatinization and heat moisture treatment. Further, the modified starches were characterized based on physical, chemical, thermal, functional, rheological, and morphological properties.

The corresponding author is Professor and Head, Department, Food Engineering & Technology, Sant Longowal Institute of Engineering & Technology, Longowal. His specialization is in Fruits and vegetable processing.

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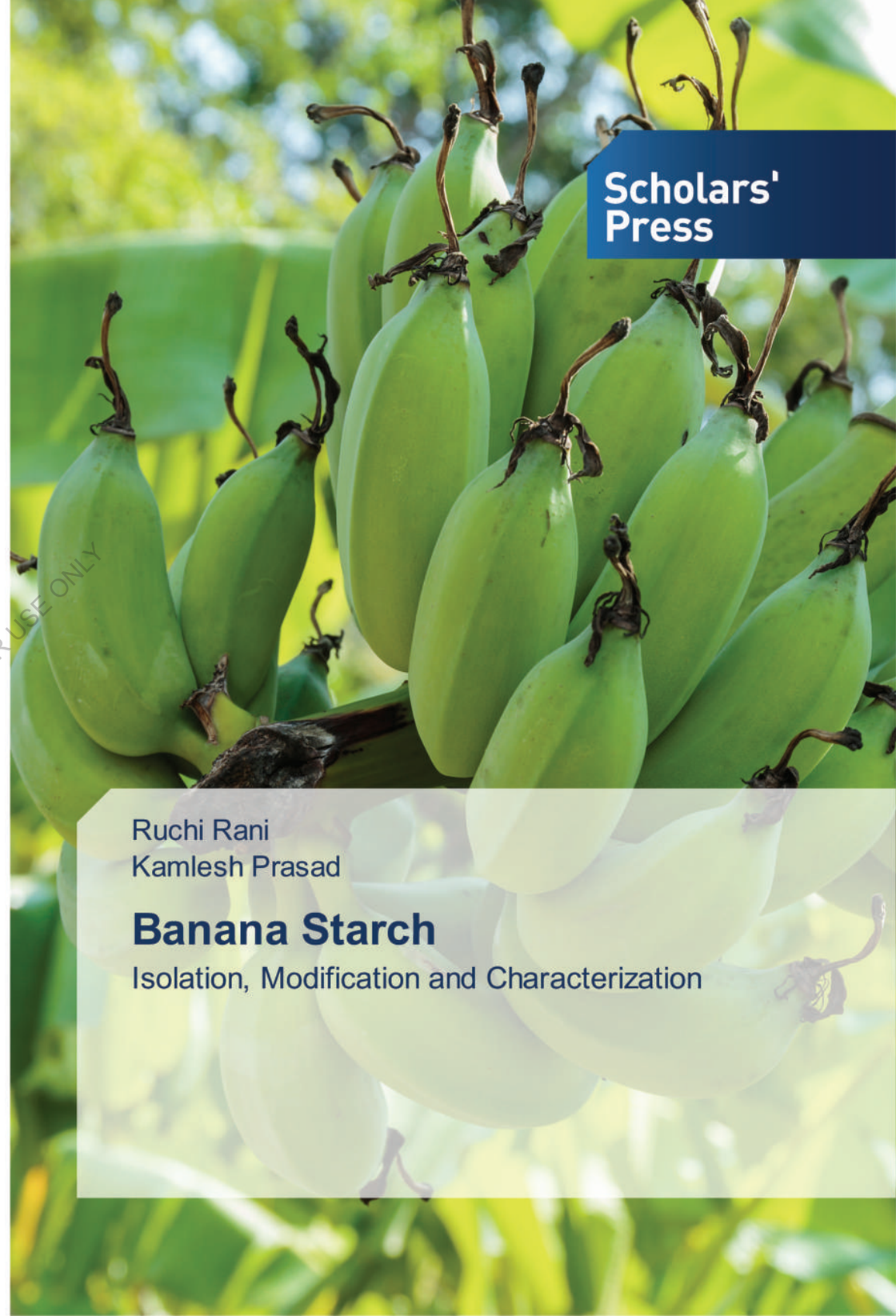

Scholars' Press

Ruchi Rani
Kamlesh Prasad

Banana Starch

Isolation, Modification and Characterization

Ready to Eat Egg Products

India is the fifth largest producer of eggs in the world with a production figure of 30 billion eggs per annum. At present, just four states, Andhra Pradesh, Tamil Nādu, Punjab, and Maharashtra account for more than 50% of the total output of eggs in the country. Considering the net protein utilization and protein efficiency ratio, the egg is considered the best source of protein apart from the other nutrient source. Thermal processing has a significant effect on the sensory, thermal, textural, nutritional, and microbial quality of processed products. Analog thermal kinetic study during heat treatment at various temperatures (75, 80, 85, 90, and 95˚C) revealed that heat transfer rate is faster at higher temperatures. The thermal treatment combination of 92.77˚C/12min resulted in optimum coagulated egg product with sensory OAA score ranging from 8.23 to 8.64 on the nine-point hedonic scale. Further studies for the development of ready to eat product was carried out using blending with yolk and spice mix at optimum temperature and time combination.

Dr. Kamlesh Prasad is Professor and Head of Department, Food Engineering & Technology, Sant Longowal Institute of Engineering & Technology, Longowal. He is involved in the development of Ready to Eat specialized food products.

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Prasad, Lovina , Shekhar

Scholars' Press

Kamlesh Prasad
Lovina Lovina
Shubhra Shekhar

Ready to Eat Egg Products

Heat Penetration Studies, Development and Optimization

Chapter 6
Non-thermal Food Preservation Technologies

Ravneet Kaur, Shubhra Shekhar, Sahil Chaudhary, Barinderjit Singh, and Kamlesh Prasad

Abstract Recent food processing trends and preservation technology mainly focus on retaining freshness and minimizing nutritional and sensory losses during processing. Conventional processing techniques involve high temperature (thermal processing) for microbial inactivation and food preservation. Exposure to high-temperature results in the loss of heat-sensitive nutritional components and affects textural and sensory characteristics of foods. Therefore, to obtain high-quality minimally processed food products, non-thermal techniques are found to be better. Standard non-thermal preservation techniques include high-pressure processing, pulsed electric field, cold plasma, supercritical carbon dioxide, irradiation, and ultrasound. This chapter focuses mainly on the principles, processing, and application of non-thermal techniques in food preservation.

Keywords Non-thermal food preservation · High-pressure processing · Pulsed electric field · Cold plasma · Supercritical carbon dioxide · Irradiation · Ultrasound

6.1 Introduction

Food preservation, safety, and quality are the significant goals of food processing industries to meet consumer demand as per the recent trends. Commonly used traditional food processing techniques involve thermal treatment for improving the production rates and shelf-life extension. Thermal processing is required to get the desired characteristics in processed food products but involves higher temperature

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S. Sehgal et al. (eds.), *Smart and Sustainable Food Technologies*,
https://doi.org/10.1007/978-981-19-1746-2_6

Chapter

Secondary Metabolites of Fruits and Vegetables with Antioxidant Potential

Ravneet Kaur, Shubhra Shekhar and Kamlesh Prasad

Abstract

An antioxidant is of great interest among researchers, scientists, nutritionists, and the public because of its ability to prevent oxidative damage, as indicated by various studies. This chapter mainly focuses on the free radicals and their types; antioxidants and their mode of action against free radicals; fruits, vegetables, and their byproducts as a source of antioxidants; and various analytical methods employed for assessing antioxidant activity. Antioxidants discussed in this chapter are ascorbic acid, Vitamin E, carotenoids and polyphenols, and their mechanism of action. Different antioxidant activity assay techniques have been reported. Fruits and vegetables are abundant sources of these secondary metabolites. The waste generated during processing has many bioactive materials, which possibly be used in value-added by-products.

Keywords: antioxidant, free radical, oxidative stress, secondary metabolite, ascorbic acid, carotenoids, polyphenol, degenerative diseases

1. Introduction

The word antioxidant is commonly heard nowadays, especially whenever there comes a topic of health concern. People consume antioxidants as a symbol of a healthy lifestyle to fight against various health problems, better skin, and anti-aging benefits. What makes antioxidants so important? The trait responsible for such importance of antioxidants is their ability to stop free radical reactions that can have potentially deleterious effects [1]. This gives rise to various questions, such as What are the free radicals? What are the sources of free radicals? What are their harmful effects? What are antioxidants? What are the common sources of antioxidants? How do they work against free radicals? Answers to these questions are discussed in the present chapter.

2. Free radicals

Free radicals are those atoms or molecules with an unpaired electron in their outer orbit [2]. Any electron present alone in an orbital is referred to as an unpaired electron, and it is accountable for the reactive and unstable state of the free radical.

CHAPTER 10

PREDICTIVE MODELING FOR PACKAGED FRUITS AND VEGETABLES

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CONTENTS

CHAPTER

2

Rheological analysis of food materials

Yogesh Kumar[a,*], *Mamta Bhardwaj*[a], *Ankan Kheto*[b] *and Dharmesh Saxena*[a]

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2.1 Introduction

A combination of carbohydrates, proteins, fats, water, and fibers is known as a food that shows complex morphological and structural properties. The structural and flow behavior of different food materials are not identical due to the non-uniform combination of these constituents. Rheological properties give us an idea about the behavior of viscoelastic fluid under varying shear force, deformation rate, concentration, temperature, and time. It is closely associated with the sensory and quality characteristics of food material. Earlier, in food materials, rheological analysis was mainly concentrated on steady-state flow behavior where the structural breakdown was the main drawback in the case of food. To overcome this problem, oscillatory and creep tests were introduced for proper characterization without altering the structural properties. With the technological advancement in instrumentation, the rotational rheometer and oscillatory rheometer can determine the required parameters under varying or constant stress/strain in a more accurate manner. Moreover, these rheometers are capable of determining nonlinear flow behavior under high shear stress or shear strain to analyze the viscosity, elasticity of complex fluids and indirectly provide the sensory and textural property of the material.

The rheological characteristics of any product depend on the source, morphological property, concentration, presence of different polymer compounds, pasting conditions, and storage conditions. For example, the rheological properties of liquid food materials are influenced

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Chapter 1

Nutraceutical-A deep and profound concept

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1.1 Introduction

Consumer awareness regarding role of nutraceuticals is the important key factor which generates demand for nutraceutical sector. Consumers have wistful longing for specialty nutrition which leads to digestive health, beauty enhancement, specific chronic health problems, and so on. The major bone problems prevailing in society like osteoporosis and arthritis have also propelled the nutritionists to work in this direction. The protein progression has also led to design specialty nutraceuticals for children. Nutraceuticals working as pharma foods help in inhibition of cardiopathy, high blood pressure, osteoporosis, high blood glucose, and for lowering saturated fatty acids (Salmeron et al., 1997).

This demand has revolutionized the food world to be offering a notable benefaction to good health as well as well-being of human beings. Nutraceutical acting as preventive foods also helps in improving the gastric and stomach problems as they work as probiotics and prebiotics as well. Overall nutraceuticals improve the immune system thus helping in fighting with harmful extraneous microorganisms. Many lifestyle-related diseases like cancer can be treated with the sensible intake of nutraceuticals. Although nutraceuticals are not the magic bullets which are directly targeting the cancer cells but they can prevent the further infections and inflammations and in turn will boost the immune system (Kessler et al., 2001). Wrong food intake habits can lead to colon cancer because of the conversion of precarcinogens to carcinogens by intestinal microflora. The enzymes like glycosides, azoreductases, and nitroreductases present in intestinal microflora convert these precarcinogens to carcinogens. The use of probiotic strains like *Lactobacillus acidophilus* and *Lactobacillus casei* helps to reduce the levels of these enzymes and so the generation of these enzymes will be reduced by imparting them anticancer effects. Many of the natural foods like fish, tomato, and green leafy vegetables have bioactive compounds which enable the oxidation of LDL. Some neurogenerative diseases like Parkinson's disease which are known to be triggered by wrong foods and on the other hand can be reduced by nutraceuticals.

Nutraceuticals are associated with following properties:

- Antioxidant properties
- Antiinflammatory properties
- Insulin sensitivity
- Anticancerous properties
- Affecting cell differentiation
- Increasing enzyme activity which helps in detoxification
- Upkeep of DNA mending
- Upsurge the programmed cell death of cancer
- Diminution in cell propagation

Nutraceuticals and Health Care. https://doi.org/10.1016/B978-0-323-89779-2.00021-1

5

Role of Fermentation on Rheological Properties and Sensory Attributes

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Introduction

Fermentation is an integral part of food processing throughout the history of mankind. In beginning, it was mainly preservation method, then it became key process in substantial sensory characteristic development and now it is utilized to improve overall properties of outcome from major industries like bakery, dairy, beverages, etc. The human understanding of controlled fermentation process changes its fundamental objective by exploring its success in development of rheological and texture characteristics.

The biochemical transformation of raw food due to fermentation affects the organoleptic as well as rheological properties of a product. The changes in rheological as well as sensory properties is related with the modification of major component by the action of microorganism. For example, transformation of polysaccharides in bread dough by action of yeast produce ethanol, CO_2 and other simple compound which modify sensory as well as rheology of dough. The major micro-structural, bio-compositional and bio-chemical changes are due to microbial action are frequently described to understand the effect of fermentation on rheological as well as sensory properties of food products. The rate and quality of these associated major changes mainly depends upon concentration of saccharides for growth of microorganism as well as nature and existing microflorae. Hence, a proper monitoring of changes in rheological and sensory properties is necessary to optimize the controlled fermentation as well as design of process parameters from engineering and consumer point of view.

The biochemical changes directly responsible for changes in basic rheological and sensory characteristic including flow behavior, consistency, viscoelastic properties, hardness, adhesiveness, color, aroma, flavor and mouthfeel. The food industry is so diverse and exploring new and possibilities to catch diverse consumer worldwide,

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Rheological and Thermal Changes Occurring During Processing

Renuka Singh, Mamta Bhardwaj, D.C. Saxena

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Contents

Introduction

Food processing comprise of techniques employed to transform raw ingredients into final food product or to preserve the food product. Food processing industry as well as at domestic scale the food processing methods aim at providing processed food products for daily consumption by humans and animals. Food processing aims at increasing the shelf life, preserve, make nutritious or ready to eat foods, and getting the best quality final products. There are various techniques and methods which come under food processing such as drying, dehydration, fermentation, pickling, freezing, mixing, pumping, pasteurization, cooking and homogenization etc.

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CHAPTER 1

Rheology: A Tool to Predict Quality of Foods

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ABSTRACT

The word "food" in itself is a complex system comprising of a wide range of biological components with various rheological characteristics. The diversity in these biological components in different food systems impart various compositional and structural variability to the food, thus, exhibiting different types of rheological behaviors viz. low viscosity fluids (e.g., milk), high viscosity fluids (e.g., ketchup) and hard solids (e.g., candies, and gel). The rheological behavior of food decides the stability and appearance of foods such as in the form of emulsions, pastes, and spreads, etc. Moreover, food quality, apart from its nutritional value, is a function of its rheological properties viz. structure and texture. The rheological characterization of food and food forming components is vital for predicting the food quality. Depending upon the form of a specific product (e.g., suspension, emulsion, gel, paste, liquid, solid, etc.) to be analyzed, a range of rheological techniques, tests, and equipments are available. Processing the rheological data in the form of models is vital to infer its physical significance in relation to the flow behavior. Therefore, the present chapter gives an insight into the application of rheological techniques, tests, and theoretical models to predict the quality of foods.

Chapter 4
Brown Rice Flour Rheology

Shumaila Jan, H.A. Pushpadass, D.C. Saxena, and R.P. Kingsly Ambrose

Introduction

Rice (*Oryza sativa* L.) is the staple food of about half the world's human population and particularly for the people in Asia. Brown rice is the dehulled rice obtained from paddy grains, with the bran and germ still intact. It consists of roughly 6–7% (w/w) of bran, 2–3% (w/w) of embryo, and 90% (w/w) of endosperm. The germ and bran layers are the nutrient-rich components in brown rice. The brown rice is normally subjected to abrasion to remove the bran layers from the endosperm and obtain white rice as the latter form is preferred by the consumers. The extent of removal of the bran layers is termed as degree of milling, which determines the whiteness of rice. During milling of brown rice, considerable amount of proteins and minerals are lost. In contrast, the brown rice with germ and bran layers is richer in nutrients such as proteins, lipids, fibres, vitamins, and minerals (Chen et al. 1998; Lamberts et al. 2007).

Rice and brown rice flours are used as primary ingredients in the preparation of many traditional and unique food products. For example, rice flour is used in the preparation of foods such as noodles, breakfast cereals, unleavened breads, snack food items, crackers, candies, and baby foods (Bao and Bergman 2004). In addition,

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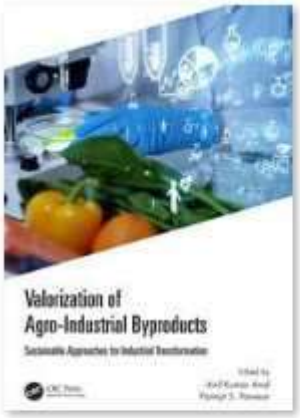
A. Manickavasagan et al. (eds.), *Brown Rice*,
DOI 10.1007/978-3-319-59011-0_4



Chapter

Ultrasound-Assisted Extraction of High Value Compounds from Agro-Industrial Byproducts

By Anuradha Saini, Divyani Panwar, Parmjit S. Panesar, Anjineyulu Kothakota

Book Valorization of Agro-Industrial Byproducts

Edition	1st Edition
First Published	2022
Imprint	CRC Press
Pages	24
eBook ISBN	9781003125679

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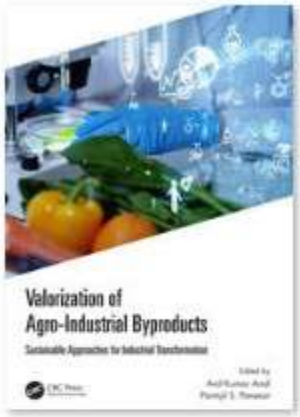
ABSTRACT

An ample amount of by-products is generated during different phases (handling chain, classification and grading, processing, storage, and marketing) of food processing. These by-products can be used to extract



Chapter

Agro-Industrial Waste as Wealth

Principles, Biorefinery, and Bioeconomy

By Anil Kumar Anal, Parmjit S. Panesar, Rupinder Kaur

Book Valorization of Agro-Industrial Byproducts

Edition	1st Edition
First Published	2022
Imprint	CRC Press
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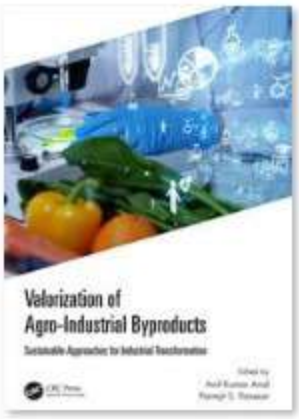
eBook ISBN	9781003125679

ABSTRACT

Food waste is not waste anymore. Every piece of waste is an opportunity, an opportunity that can be valorized into resources and energy that could be a viable strategy for reducing the environmental impacts of food waste. Essential nutrients and bioactive compounds can be extracted from agro-food waste that would otherwise remain unused. Going into the future, viable approaches for utilizing these wastes for the



Chapter

Production of Organic Acids from Agro-Industrial Waste and Their Industrial Utilization

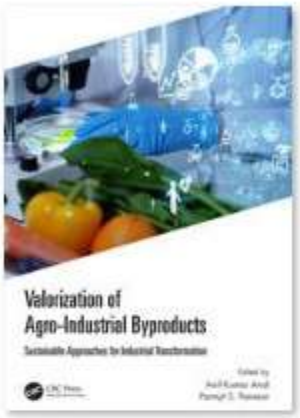
By Navneet Kaur, Parmjit S. Panesar, Shilpi Ahluwalia

Book Valorization of Agro-Industrial Byproducts

Edition	1st Edition
First Published	2022
Imprint	CRC Press
Pages	38
eBook ISBN	9781003125679

ABSTRACT

Agro-industrial waste, being rich in nutrients, is used nowadays as an alternative for the production of bio-products like bioenergy, biofuels, and high value-added chemicals. Organic acids are biochemicals that have gained worldwide attention due to their vast industrial applications. Microbial fermentation processes



Chapter

Production of Biopigments from Agro-Industrial Waste

By Neegam Nain, Gunjan K. Katoch, Sawinder Kaur, Sushma Gurumayum, Prasad Rasane, Parmjit S. Panesar

Book Valorization of Agro-Industrial Byproducts

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First Published	2022
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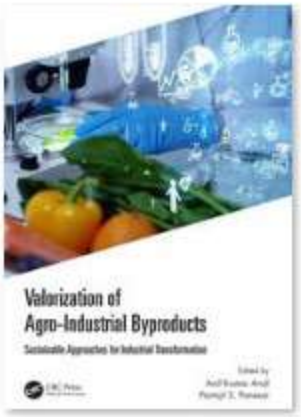
ABSTRACT

Owing to the negative impact of synthetic colourants on human health, nowadays, there is an increasing trend to replace these colourants with natural counterparts for their utilization in the food-processing industry. These natural counterparts or natural pigments are mainly isolated and derived from plant sources



Chapter

Sources, Composition, and Characterization of Agro-Industrial Byproducts

By Dipak Das, Parmjit S. Panesar, Gaurav Panesar, Yakindra Timilsena

Book Valorization of Agro-Industrial Byproducts

Edition	1st Edition
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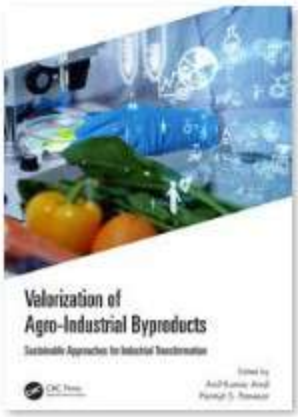
ABSTRACT

Agro-industrial by-products from the food-processing industry are increasing significantly with the increase in global population, globalization of the food trade, and subsequent increase in food-processing operations



Chapter

Production of Enzymes from Agro-Industrial Byproducts

By Rupinder Kaur, Parmjit S. Panesar, Gisha Singla

Book Valorization of Agro-Industrial Byproducts

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First Published	2022
Imprint	CRC Press
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eBook ISBN	9781003125679

ABSTRACT

Enzymes are crucial for humans and have infinite applications in various sectors, especially in the various bioprocess techniques. Although enzymes can be isolated from plants as well as animals, microbial sources

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Prebiotics and their Role in Functional Food Product Development

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11.1 Introduction

For a long time, apart from the basic role of food to provide nutrients to humans for their necessary growth and development, some important aspects such as improvement of health and preventing diseases have been gaining importance. With the boosted interest of consumers in self-care and enhanced quality of life, research to understand the impact of interaction between the diet, gut and health has increased rapidly (Niva 2007; Rastall 2010). The human gut is known to be one of the most active metabolic organs containing a complex community of microorganisms or microbiota that affects the host's health (Holscher 2017). Moreover, it is a well-established fact that the gut microbiota maintains a synergetic relationship with the host and plays a critical role in various biological functions including utilization of nutrients, assistance in host digestion, strengthening of the immune system and protection against infectious pathogens (Bindels *et al.* 2015). However, certain undesirable changes/imbalance in patterns of gut microbiota known as dysbiosis are responsible for specific gastrointestinal and immune-mediated disorders such as celiac disease, Crohn's disease, obesity, liver diseases, multiple sclerosis, arthritis and cancer (Anadón *et al.* 2016).

This has led to the idea that deliberate manipulation in composition or metabolic activity of gut microbiota can be utilized as a therapeutic target to improve host health. As a consequence, utilization of functional foods and dietary supplements such as prebiotics, probiotics and synbiotics to regulate gut microbiota has gained interest, which has led to a brisk augmentation in the global market (de Preter and Verbeke 2014). The global market size for functional foods is currently estimated at USD 161.50 billion, and is predicted to rise to approximately USD 275.80 billion by the year 2025 (Figure 11.1). The chief leaders of the functional food market include the United States, Japan and Europe, whereas India, China and Latin America, along with some other Asian countries, are experiencing a high market growth rate (https://www.grandviewresearch.com/industry-analysis/functional-food-market/).

Probiotics, Prebiotics and Synbiotics: Technological Advancements Towards Safety and Industrial Applications, First Edition. Edited by Parmjit Singh Panesar and Anil Kumar Anal.

1

Probiotics, Prebiotics and Synbiotics: Opportunities, Health Benefits and Industrial Challenges

Parmjit Singh Panesar[1], *Anil Kumar Anal*[2] *and Rupinder Kaur*[1]

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1.1 Introduction

Ever since the "Theory of Longevity" was proposed by Elie Metchnikoff and was correlated with prolonged youth and healthy old age, the search for food components as well as nutrients that not only enhance health but also help prevent disease has expanded, as has understanding of their role. Over the past few decades a plethora of novel foods have indicated specific health benefits, and those foods have been termed "functional foods" (Anal 2019; Noomhorm *et al.* 2014). The functional foods concept applies to those food products that exhibit various health beneficial properties to the host, apart from nutrition; hence this has become a recent area of research worldwide (Rastall 2010). Since its introduction, the global market demand for these foods has enlarged and market size is predicted to increase from USD 150 billion in 2018 to USD 250 billion in the next few years. The major leaders in this market are the United States, Europe and Japan, whereas China, India, Latin America and some of the other Asian countries are emerging as the fastest growing market (Patel and Goyal, 2012). In recent years, the functional food concept has moved progressively towards the development of dietary supplements that may have a profound effect on the gut microbial composition and activities.

The human microbiota comprises approximately 10^{14} microbial cells, which are 10 times greater in number than the cells of the human body (Savage 1970). Among all the parts or surface of the human body, the gastrointestinal tract is one of the most heavily colonized organs, accommodating about 70% of all the microbes in the human body (Figure 1.1) and playing a crucial role in health and disease (Ley *et al.* 2006). Changes in the gastrointestinal ecosystem or an imbalanced gut microflora have been associated with the occurrence of several diseases, including inflammatory bowel disease, diarrhea, colon cancer and many others.

Probiotics, Prebiotics and Synbiotics: Technological Advancements Towards Safety and Industrial Applications, First Edition. Edited by Parmjit Singh Panesar and Anil Kumar Anal.

Chapter 12

Galactooligosaccharides as Potential Prebiotics

Rupinder Kaur, Parmjit Singh Panesar

Book Editor(s):Parmjit Singh Panesar, Anil Kumar Anal

First published: 07 January 2022 | https://doi.org/10.1002/9781119702160.ch12 | Citations: 1

Summary

Over the past decade, galactooligosaccharides (GOS) have been globally recognized as prebiotic substances and have fascinated various researchers worldwide. Owing to their various physiological properties as well as enormous health benefits, the demand for GOS among the growing population has substantially increased. GOS can be extracted from a variety of natural sources, but in small quantities, and there is a need to scale up GOS production to fulfill ever-increasing demand. Both chemical and enzymatic methods have been reported for production, yet in comparison to the former, the latter techniques have been most widely explored owing to the various techno-economic benefits. Various biotechnological approaches, such as whole cells, free, immobilized and recombinant enzymes, have been proposed by researchers globally to enhance the

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Lactulose: Production and Potential Applications

Shweta Kumari[1], Parmjit Singh Panesar[2], Divyani Panwar[2] and Gisha Singla[2]

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14.1 Introduction

The disaccharide lactulose (4-O-β-D-galactopyranosyl-D-fructofuranose) is a non-digestible compound made up of two monosaccharides, fructose and galactose, bonded together with a β-1,4-glycosidic bond. It is a "bifidus factor", which is produced by lactose isomerization. The β-glycosidic linkage present in lactulose is not hydrolyzed by digestive enzymes and the ingested lactulose is directly passed through the colon in an unaltered form (Ruttloff *et al.* 1967). It is generally utilized by a large number of probiotic bacteria such as *Bifidobacterium* spp., present in human intestine (Figure 14.1) (Tamura *et al.* 1993). Due to its prebiotic property, it induces the growth of healthy gut bacteria such as bifidobacteria and lactobacilli (Table 14.1) and also inhibits the growth of pathogenic bacteria such as *Salmonella* (Aider and de Halleux 2007; Panesar *et al.* 2009).

14.2 Structure and Properties

Lactulose is a non-digestible synthetic isomer made up of two monomers, galactose and fructose. The structural and physicochemical properties of lactulose are shown in Table 14.2. Lactulose is predominantly found in a variety of isomeric forms including α- or β-pyranose, α- or β-furanose, and acyclic forms. Among these, α-furanose β-pyranose and β-furanose isomers are mainly formed during the currently available methods of lactulose production at different ratios, but the presence of α-pyranose has not been reported (Aït-Aissa and Aider 2014a).

Lactulose syrup available commercially is a clear yellow and odorless sweet syrup containing about 80% solid contents (Schumann 2002). Moreover, pure lactulose is commercially available in white crystalline form and is made up of anhydride and trihydrate structures

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Potential of Nanotechnology in Food Analysis and Quality Improvement

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Anuradha Saini, Divyani Panwar, Parmjit S. Panesar, and Pranjal Chandra

Abstract

Nanotechnology has reformed the food sector with producing better-quality food products through its contribution in functional foods development, food nanopackaging, and nanodevices for food analysis. The existing techniques such as culture-based techniques, sensory analysis, and GC techniques for food analysis are time consuming, cumbersome, and labour intensive. To overcome these drawbacks, nanotechnology is nowadays applied to develop techniques that show more accurate and precise results, which is important for maintaining food quality. Nanotechnology in food analysis is used to detect toxins, adulterants, pathogens, sugar, and antioxidants using nanodevices like nanosensors. Furthermore, nanotechnology can also be applied in food packaging and processing domain to sense food spoilage as well as improve food quality. This chapter delivers comprehensive information about the value and potential of nanotechnology for food analysis, packaging, and quality improvement in the food processing domain.

Keywords

Nanotechnology · Food analysis · Food packaging · Nanosensors · Quality

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Chapter 6

Recovery of Nutrients and Transformations of Municipal/Domestic Food Waste

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Summary

This chapter provides comprehensive information on different aspects of characteristics of food waste, its supply chain and recovery of valuable products from anaerobic digestion of food waste, and novel approaches for the transformation of food waste into valuable products through chemical and biotechnological routes. Food waste is generated throughout the food supply chain and is produced when the desired product is separated from undesirable product. Anaerobic digestion is an efficient and vital technology used globally for the proper disposal and treatment of food waste. This technology has proven to be a promising and environmentally friendly approach for the management of food waste as well as the production of a variety of valuable products including biogas and digestate. The chapter describes the biotechnological and chemical

CHAPTER

13

Biotechnological approach for valorization of whey for value-added products

Rupinder Kaur, Divyani Panwar and Parmjit S. Panesar

Glossary

Bioaugmentation	It is a technique in which archaea or bacterial cultures are added to speed up the rate of degradation of the contaminant.
Crabtree effect	It is the phenomenon in which yeast (*Saccharomyces cerevisiae*) produces ethanol in aerobic conditions and high glucose concentrations rather than producing biomass via the tricarboxylic acid (TCA) cycle.
Enzymes	Enzymes are macromolecular biological catalysts that accelerate chemical reactions.
Exopolysaccharide (EPS)	These are high molecular weight natural polymers composed of sugar residues and are secreted by microorganisms into their environment.
Fermentation	It is a metabolic process that produces chemical changes in organic substances through the action of enzymes of microbial origin.
Immobilization	Cells/enzymes physically confined or localized in certain region of space with retention of their catalytic activities, which can be used repeatedly and continuously.
Prebiotics	These can be defined as nondigestible food ingredients that allow specific changes both in the composition and/or activity in the gastrointestinal microbiota, thus, conferring various health benefits upon the host.

13.1 Introduction

Dairy practices have been considered as an integral part of human civilization since bygone times. This industry is an indispensable part of the food industry, which processes raw milk into numerous dairy products with the subsequent generation of different by-products (Fig. 13.1). This sector plays a momentous role in the growth of global economics as well as acts as a proactive contributor to human nutrition. According to the FAO (2018), world milk production was estimated to be 811 million tons in 2017, which was up 1.4% from 2016. An enormous amount of waste, which is estimated between 3.739 and 11.217 million cubic meters is generated from the dairy industry, including both solid and liquid wastes. The effluents discharged from the dairy industry exhibit different characteristics depending upon the type of product produced, climate, operating conditions as well as cleaning-in-place practices (Prazeres et al., 2012).

During the manufacturing of dairy products, approximately 85%–90% of the total milk used is discarded as the liquid by-product known as whey (Panesar and Kennedy, 2012). Whey is a milk serum or watery medium in which all milk phases are homogeneously dispersed (Kosseva, 2013). The total worldwide production of whey is around 180 to 190 million tons per year, among which, the major producers are the European Union and the United States (Fig. 13.2), which contribute approximately 70% of the global whey production (Mollea et al., 2013). Further, it is estimated that the global production will increase to 200 million tons per year (Domingos et al., 2016). It is a rich source of nutrients such as lactose (4.5%–6%), proteins (0.6%–1.1%), water (93%–94%) as well as other micronutrients (Carvalho et al., 2013). Owing to these, the biological oxygen demand (BOD) as well as chemical oxygen demand (COD) levels of whey are quite high varying between 35 and 60 g/L and 50 and 102 g/L respectively (Remón et al., 2016); thereby leading to serious environmental problems.

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CHAPTER 3

BIO-PROCESSING OF FOODS: CURRENT SCENARIO AND FUTURE PROSPECTS

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Enzyme Production by Submerged Fermentation and Their Importance in Food Industry

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Introduction

The entire living organism from the smaller creatures viruses to the advanced human beings are composed of a set up of biochemical reactions which form the metabolism. These set of metabolic reactions are responsible for the life of organism. The rate of these reactions is a major concern for effective working of organism which is governed by biocatalyst. These biocatalysts are known as enzymes, which accelerates rate of biochemical reaction. These are not utilized in reaction. In 1877,

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Science and Technology of Fruit Wine Production

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Chapter 1 - Science and Technology of Fruit Wines: An Overview

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Abstract

Wine is one of the oldest known alcoholic beverages, tracing its

SUBCHAPTER 7.2

STONE FRUIT WINES

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1. INTRODUCTION

Apricots, plums, peaches, and cherries are the major stone fruits grown the world over (Westwood, 1978; Bhutani and Joshi, 1995; Joshi et al., 2012). These fruits are highly perishable commodities and have to be either consumed immediately or preserved in one or another form. In the developed countries, a considerable quantity is utilized to prepare processed products from these fruits. But in developing countries, lack of proper utilization results in considerable postharvest losses, estimated to be 30–40% (Joshi et al., 2000, 2011a). Conversion of such fruits into wine of acceptable quality, especially in the developing countries, could save these precious resources to a greater extent.

Although production of wine is largely done by the fermentation of grape juice, it has also been practiced widely using fruits such as apples, cherries, currants, peaches, plums, strawberries, etc. (Vyas and Chakravorty,1971; Merine et al., 1980; Joshi et al., 2011a,b). Consumption of wine has assumed a great importance largely due to the presence of phenolic compounds and resveratrol (Joshi and Devi, 2009; Joshi et al., 2011a), which are helpful in preventing cardiovascular disease. Plum wines are also quite popular in many countries, particularly in Germany and Pacific Coastal states (Amerine et al., 1980; Joshi et al., 1999a). The stone fruits, including plum, have many common characteristics, like pulpy nature, appealing color, sugar, high acid, minerals, etc., and can be utilized for the preparation of wine and brandy. Thus, the production of wines in those countries where stone fruits are grown would be advantageous (Joshi and Kumar, 2011). A brief review of the technology of wine production and composition of wine from stone fruits is described in this subunit.

2. PRODUCTION OF STONE FRUIT WINES: GENERAL ASPECTS

2.1 PRODUCTION

Stone fruits are cultivated throughout the world over and occupy an area of 5.07 million ha, with 35.24 million tons produced. In India, about 43,000 ha are planted with apricots, peaches and nectarines, plums, and cherries, with an annual production of about 0.25 million tons (FAO, 2008). The increased production of these fruits can be used profitably, if fruit wines are produced, thus generating employment opportunities and providing better returns to the orchardists (Vyas and Chakravorty, 1971; Sandhu and Joshi, 1995; Joshi et al., 2004).

SUBCHAPTER 7.4

CITRUS WINES

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1. INTRODUCTION

Citrus is the most economically important tree fruit crop in the world. These fruits may be divided into three botanical species: *Citrus sinensis*, the common orange; *Citrus nobilis*, the mandarin group; and *Citrus documana*, the grapefruit (von Loesecke et al., 1936). Of these, orange is the most commonly grown citrus fruit in the world. In 2012, 68.2 million tons of oranges were grown worldwide, primarily in Brazil, the United States, China, and India (FAO, 2014). The majority of citrus arrives at market in the form of processed products, such as single-strength orange juice and frozen juice concentrate. One possible use of citrus fruits is in the production of fruit wines. Several classes of citrus fruits are available for the preparation of wine and other alcoholic beverages.

Wine is defined as an alcoholic beverage, which is produced by the fermentation of fresh grapes or must, and winemaking is one of the most ancient technologies and is now one of the most commercially prosperous biotechnological processes. Grapes and apples are the crops most widely grown for the production of juice for winemaking. Although grapes and apples are by far the most often used fruits, various other fruits such as oranges, kiwi, peaches, and plums may also be used to make wine. Increasing interest in human health, nutrition, and disease prevention has enlarged the consumer demand for functional food, including fruits and their products such as wine (Rupasinghea and Clegg, 2007). Additionally, the global food industry uses a variety of preservation and processing methods to extend the shelf life of fruits and vegetables so that they can be consumed year round and transported safely to consumers all over the world, not only those living near the growing region (Barret and Lloyd, 2012). Therefore, the utilization of ripe fruit or their juices for wine production is considered an attractive means of utilizing surplus and overripe fruit (Jagtap and Bapat, 2015).

2. ORANGE WINE

Oranges vary in color, flavor, acidity, and sugar profile depending upon the soil character and climate in the regions where they are grown and the methods of horticulture applied in orange orchards. It is recommended that fully ripened, even a bit overripened, oranges be considered to achieve low acidity, good color, and good flavor. Orange juice is well known for its high acid content; producing an orange wine with good balance is a major challenge of utmost importance to the winemaker. Without this balance, orange wines are excessively acidic in character. In addition to high acidity, orange does not have

SUBCHAPTER

PRODUCTION OF WINE FROM TROPICAL FRUITS

7.5

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1. INTRODUCTION

The tropics are generally defined as the regions of the globe that lie between the Tropic of Cancer and the Tropic of Capricorn, and the environmental conditions there are unique, creating a habitat for incredibly diverse animals and plants. Tropical zones on earth are areas where the sun is directly overhead once a year and have only two seasons, namely, wet and dry. The tropics are warm year-round, and they are also very humid, with some areas receiving lots of rain every year. Tropical plants and their fruits have adapted to this climate. Many tropical fruits are large, brightly colored, and very flavorful so that they appeal to the animals they rely on to distribute their seeds. Tropical fruits have been used by humans for centuries, and certain fruits are in high demand all over the world. They are cultivated mostly in countries with warm climates and the only character that they share in common is frost intolerance (Morton, 1987; Reddy et al., 2012).

Some tropical fruits—mango, banana, pineapple, papaya, pomegranate, guava, custard apple, lychee, ber, melon, star fruit (or carambola), kiwi, date, and passion fruit—are well known all over the world. In fact, the banana is one of the highest selling fruits around the world. They can be grown, harvested, and transported easily. Many of these fruits are available in big markets year-round. Other tropical fruit cultivars are more obscure. Although they may be popular in specific regions of the world, they are not familiar to people outside of those areas, and some of them definitely possess an acquired uniqueness in taste. Some more obscure examples of tropical fruit include soursop, cherimoya, sugar apple, jackfruit, durian, acerola, mamey, ackee, breadfruit, lychee, rambutan, and mangosteen. Some of these fruits, like jackfruit and durian, are infamous for their strong odor and flavor, whereas others like mangosteens, lychees, and cherimoyas are quite simply delicious, but difficult to cultivate (Morton, 1987).

Mango, pineapple, avocado, and papaya are known as major tropical fruits. The major mango producers are India, Thailand, and Mexico, and for pineapple the Philippines, Thailand, and China. The avocado is produced in Mexico, Indonesia, and the United States. Papaya is produced in India, Brazil, and Mexico, mostly. In the present chapter, the authors have given ample attention to major tropical fruits. World production of tropical fruit will reach 82 million tons in 2015 (FAO, 2014). Ninety percent of tropical fruits are produced in developing countries. Tropical fruit production helps in creating jobs, increasing farmers' income, food security, and reducing poverty levels. Various aspects of fruit-based alcoholic beverages other than those from grapes have been investigated (Barnett, 1980). The Rigveda amply testifies that wine is perhaps the oldest fermented product known to humans. However, the actual birthplace of wine is still unknown, though it was prepared