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Formulation, Processing, and Shelf Life Management of Cookies: a Narrative Review

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Abstract

Cookies are commonly formulated with wheat flour, shortening, sugar, salt, eggs, leavening agents, emulsifiers, antioxidants, antimicrobial agents, colorants, and flavoring agents. Recent consumer trends have led to the incorporation of dietary fiber, proteins, or plant extracts to address health conditions and dietary preferences such as veganism. Cookies are susceptible to chemical, physical, and microbiological spoilage, necessitating appropriate measures to maintain quality and extend shelf life. This review explores the functional roles of ingredients, novel trends in cookie formulations, factors affecting shelf life, strategies for shelf life extension, and assessment techniques including real-time studies, accelerated shelf life testing, and predictive modeling. Microbial spoilage of cookies is controlled by reducing water activity, proper cooling and packaging, incorporating antimicrobial agents, and maintaining Good Manufacturing Practices while physical spoilage is minimized using moisture absorbers and low-permeability packaging. Chemical spoilage can be controlled by lowering storage temperature, limiting oxygen exposure, and incorporating antioxidants.

***Keywords*:** biscuit, formulations, physical spoilage, microbiological spoilage, chemical spoilage, shelf stability.

Abbreviations: AGE - Advanced glycation end products, Aw - Water activity, BHA - Butylated hydroxyanisole, BHT - Butylated hydroxytoluene, EVA - Ethylene vinyl acetate, FDA - Food and Drug Administration, GI - Glycemic index, GMP - Good Manufacturing Practices, HMF - 5-Hydroxymethylfurfural, POA - Pro-oxidant additive, TBHQ - Tertiary butylhydroquinone

1. Introduction

Cookies are one of the most popular dry baked products (with a low moisture level ~2% to 5%) [1], that is available in range of flavors and shapes and is sweet in nature. Cookies are typically produced using soft wheat flour with a relatively high fat and sugar content. Some cookies are enriched by incorporation of nuts, dry fruits, and chocolates and the final product has a high sugar and fat content as compared to other sweet biscuits.

By 2023, North America had the highest revenue share (33.7%) in the global cookie market. Owing to urbanization and increased disposable income, the cookie market in the Asia-Pacific region is also growing rapidly. The United Kingdom has been recognized as a promising market for cookies in Europe, and there is a trend for whole-grain, gluten-free, vegan, and organic cookies in this region. According to recent reports, the global cookies market value may increase to USD 39.6 billion by 2030. Among the two distribution channels of cookies, the offline distribution channel may gain higher revenue than the online distribution channel. Trend analysis suggests that bar cookies, including chocolate chip cookies and oatmeal raisin

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cookies, may obtain the highest market share by 2030 [2].

The overall quality of cookies and shelf life depend on multiple factors, including the developed cookie formulation, processing methods, and storage conditions. Therefore, it is important to explore and understand the impact of these factors on the quality and shelf stability of cookies. While individual aspects of cookie technology have been addressed in previous literature, this review provides a comprehensive integration of formulation strategies, processing technologies, and shelf life management approaches, with particular emphasis on recent innovations in functional ingredients and sustainable preservation methods. This integrated perspective is timely given the growing consumer demand for nutritionally enhanced cookies and the industry's transition toward natural preservatives and eco-friendly packaging solutions.

Therefore, the purpose of this review was to critically addresses: (1) functional roles of ingredients and emerging formulation trends, (2) processing technologies and their quality implications, (3) mechanisms of deterioration and shelf life extension strategies, and (4) methods for shelf life assessment including predictive modeling approaches. The literature search methodology adopted for this review is described in Section 2.

2. Literature search methodology

A narrative review was conducted through a comprehensive search of peer-reviewed literature from major scientific databases including Web of Science, Scopus, PubMed, Google Scholar, and ScienceDirect. The search was performed between July 2024 and September 2025 using the following keywords and their combinations: "cookie formulation," "biscuit ingredients," "cookie processing," "shelf life of cookies," "cookie spoilage," "microbial spoilage bakery," "chemical spoilage cookies," "accelerated shelf life testing," "cookie packaging," and "functional cookies."

Inclusion criteria were: (1) peer-reviewed original research articles and review articles published in English; (2) studies directly related to cookie or biscuit formulation, processing, spoilage, or shelf life; and (3) publications from 1989 to 2025. Exclusion criteria included: (1) studies not available in full text; (2) conference abstracts without full papers; and (3) studies focused on products other than cookies or biscuits.

A total of 62 references were selected based on their direct relevance to the review objectives. Additional sources including food standards documents, technical reports, and book chapters were also consulted where appropriate. Data extraction was performed by the first author and verified by the corresponding author.

3. Key ingredients used in cookie formulations and their functions

3.1. The role of basic ingredients

The main ingredients used in cookie production include wheat flour, shortening, sugar, salt, eggs, leavening agents, emulsifiers, antioxidants, antimicrobial agents, colorants, and flavoring agents. Many studies have assessed the potential of utilizing alternative ingredients to improve the nutritional value and flavor of the product [3]. Wheat flour provides rheological characteristics through glutenin and gliadin proteins, which form gluten networks that retain CO_2 during leavening and provide dough elasticity [4]. Shortening (butter, margarine, oils) tenderizes dough, improves texture, prevents starch retrogradation, and extends shelf life [5,6]. Sugar controls spreadability, facilitates leavening through crystal-created air pockets, contributes to Maillard browning, and slows starch gelatinization [7,8].

Salt strengthens dough, inhibits microbial growth through osmosis, and affects protein aggregation and air bubble formation [9,10]. Eggs provide structure through binding and gelatinization, contribute to leavening via water evaporation, and act as emulsifiers due to lecithin content. The most common chemical leavening agents are ammonium bicarbonate (INS 503 ii) and sodium bicarbonate (INS 500 ii), which produce chemical leavening gases, such as CO_2 and NH_3. These gases can create air bubbles in biscuit dough [11].

Additives include lecithin as an effective substitute for eggs and saturated fats [12]. Antioxidants (BHA, BHT, TBHQ) to prevent lipid oxidation, and antimicrobial agents (benzoic acid, sorbic acid; maximum 1000 mg/kg per CODEX STAN 192-1995) to extend shelf life [13].

3.2. Functional ingredients and innovative formulas

Current consumer trends drive incorporation of dietary fiber, protein, and plant extracts to address health conditions, allergies, and dietary preferences such as veganism.

3.2.1. Fiber-enriched cookies

Dietary fiber enrichment utilizes various sources including defatted rice bran (10-20% substitution), banana and banana peel flour (15% substitution increases crude ash content by 93.25% and crude fiber by 197.56%), and fructooligosaccharides (up to 60% sugar replacement) [14-16]. Fiber-enriched formulations can achieve low-GI status through soluble fibers like inulin and glucans, making them suitable for diabetic consumers [17].

3.2.2. Protein-fortified cookies

Whey protein concentrate at 4% supplementation provides optimal balance between nutritional enhancement and sensory acceptability [18].

3.2.3. Sugar and fat-reduced cookies

Fat and sugar reduction strategies include fat mimetics (raftiline, simplesse, polydextrose) and sugar alcohols (lactitol, sorbitol, maltitol), though moisture content and water activity require monitoring [19]. Alternative approaches include artificial sweeteners combined with prune puree for fat replacement, maintaining sensory quality while improving nutritional profiles [20].

3.2.4. Gluten-free cookies

Gluten is a mixture of proteins available in wheat, rye, barley, and their crossbreeds. According to FDA products qualify as “gluten-free” when gluten content is <20 mg/kg. Alternative flours including rice, maize, sorghum, pearl millet, buckwheat, bajra, ragi, and coconut can produce nutritionally superior gluten-free cookies with acceptable sensory properties, though texture typically becomes harder than wheat-based cookies [21-23].

3.2.5. Vegan cookies

According to FDA, vegan foods exclude all animal-derived products, including eggs and dairy. Defatted rice bran extract (7-27%) serves as a protein source for vegan cookies, while fruit peel extracts (apple, pomegranate) can replace portions of flour and sugar, with apple peels improving spread ratio and pomegranate peels enhancing antioxidant content despite increased hardness and astringency [24,25].

3.2.6. Functional cookies with plant extracts

Diverse plant materials enhance cookie functionality: *Opuntia ficus-indica* f. *inermis* increases dietary fiber, minerals, and antioxidant activity while improving fat retention and oxidative stability [26]; germinated legumes (kidney beans, chickpeas) improve protein digestibility [27]; amaranth flour enhances spread ratio and nutritional profile [28]; and modified cassava flour combined with protein-rich sources provides wheat-free alternatives with extended shelf life [29,30].

4. Processing of cookies

4.1. Key processing steps and their impact on shelf life

Basic processing steps comprise raw material receiving, mixing, molding, baking, packaging, storage, and transportation (Figure 1) [31].

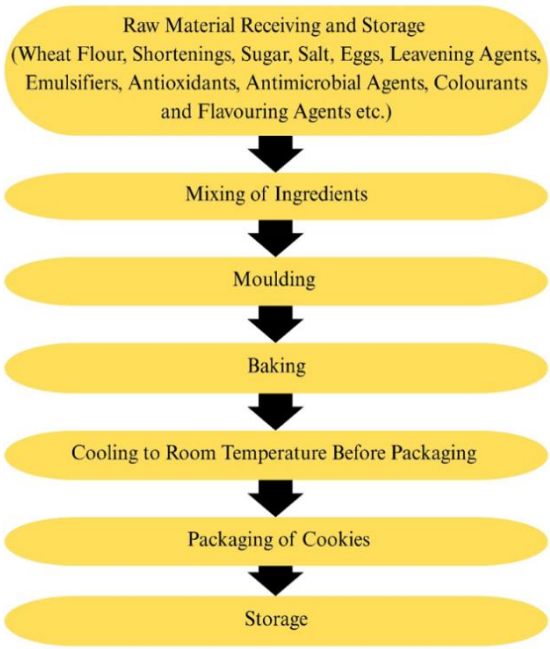

Figure 1. The process flow diagram for typical cookie processing. This diagram outlines the basic processing steps of cookie production such as raw material receiving, mixing, moulding, baking, packaging, storage and transportation

4.2. Raw Material Receiving and Storage

Raw materials may contain physical (glass, fiber, metal), biological (spoilage microorganisms), and chemical contaminants affecting cookie quality and safety [32]. Physical contaminants are removable via sieving / filtration and metal detectors. HACCP studies identified inappropriate moisture/protein

levels, foreign materials, and insects as main raw material issues, manageable through First-in-First-out systems [33].

Critical storage conditions include: according to FDA, eggs at ≤40°F (277.59 K) in original cartons for ≤3 weeks; wheat flour at 70°F (294.26 K) and 70% RH [34] and amorphous sucrose at <40% RH and <25°C (298.15 K) in vacuum-sealed packaging [35].

4.3. Pre-processing

Mixing and molding require strict hygienic conditions with proper personal protective equipment. Ingredient ratios critically affect final product flavor and texture [33].

4.4. Baking

Baking induces physical, chemical, and biochemical changes, creating light, porous structures through volume expansion, protein denaturation, starch gelatinization, flavor / aroma development, browning reactions, and crust formation while reducing moisture content, microbial activity, and enzymatic activity [36]. Typical conditions range from 176-220°C (449-493 K) for 10-20 min depending on cookie type [20, 31].

Chemical reactions during baking include Maillard browning, caramelization, and lipid oxidation, producing desirable colors/flavors but potentially forming heat-induced toxicants. Advanced glycation end products (AGEs) and 5-hydroxymethylfurfural (HMF) formation are temperature- and time-dependent: AGEs peak at 150°C then decrease at 180°C; HMF at 180°C is 36-fold higher than at 160°C; AGE formation increases from 8 to 13 min then decreases. Formulation impacts include: fructose increases HMF versus sucrose; whole wheat flour shows 30% higher AGE than refined flour; butter-based recipes contain 12% lower AGE than vegetable oil-based recipes [37]. Concurrent with browning, sucrose and starch hydrolyze to glucose, fructose, maltodextrin, and maltose [1]. Baking at high temperatures reduces water activity to <0.60, ensuring microbiological stability. Immediate packaging after cooling prevents moisture absorption and microbial contamination.

4.5. Packaging and storage

Cookies require room temperature storage in composite flexible packaging with low oxygen / moisture permeability. Techniques include vacuum packaging, modified atmospheric packaging, and active packaging with moisture /oxygen absorbers [38]. Suitable materials include orientated polypropylene (or acrylic-coated for higher oxygen barrier), metallized films (to reduce photooxidation), and modified multilayer polymeric materials with minimal environmental impact [39]. Selection depends on seal date, permeability (O_2, moisture, CO_2), cookie thickness, and unit weight.

5. Spoilage of cookies

As shown in Figure 2, cookies are subjected to physical, chemical, and microbiological spoilage. Physical and chemical spoilage predominate in low- and intermediate-moisture bakery products, while microbiological spoilage occurs primarily in high-moisture bakery products [40].

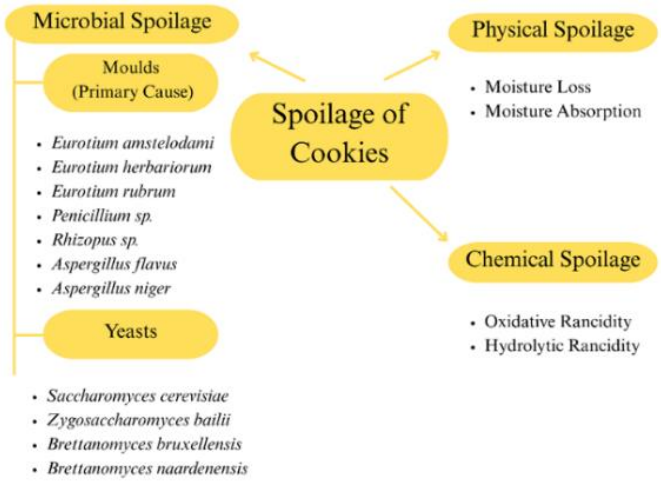

Figure 2. Spoilage mechanisms of cookie. This diagram illustrates the main spoilage mechanisms of cookies such as microbiological, chemical and physical spoilage and along with their underlying causes.

5.1. Physical Spoilage

Moisture loss or absorption causes texture loss or undesirable microbial growth [1,40]. Moisture migration occurs when equilibrium between product and atmospheric relative humidity is lacking. Undissolved or recrystallized ingredients (e.g., sugar) exhibit humectant properties, absorbing moisture from the product [1].

5.2. Chemical Spoilage

Oxidative and hydrolytic rancidity cause chemical spoilage through fat degradation. Hydrolytic rancidity releases short-chain fatty acids producing off-flavors and aromas through lipase action or spontaneous reactions. Oxidative rancidity results from oxygen interaction with unsaturated fatty acids via free radical mechanisms. Factors affecting lipid oxidation include fatty acid composition, degree of unsaturation, presence of pro-oxidants and antioxidants, oxygen partial pressure, surface exposure, and storage conditions.

5.3. Microbial spoilage

Microbiological spoilage primarily limits cookie shelf life. Yeasts and molds cause most spoilage; bacterial spoilage is limited by low water activity. However, *Bacillus subtilis* contaminates flour and sugar, with 55% of heat-resistant spores surviving during baking [41]. Common mold species [Figure 2] prefer water activities of 0.65 [42]. Although mold spores destroyed during baking post-baking contamination occurs through air, handlers, packaging materials, and equipment during packaging, storage, and transportation due to poor hygienic practices [43].

6. Key factors influencing cookie shelf life

Shelf life is the production-to-consumption interval maintaining satisfactory appearance, taste, aroma, texture, and nutritional value. Both intrinsic factors (product-associated) and extrinsic factors (environmental exposure) affect shelf life independently or interactively (Figure 3) [44].

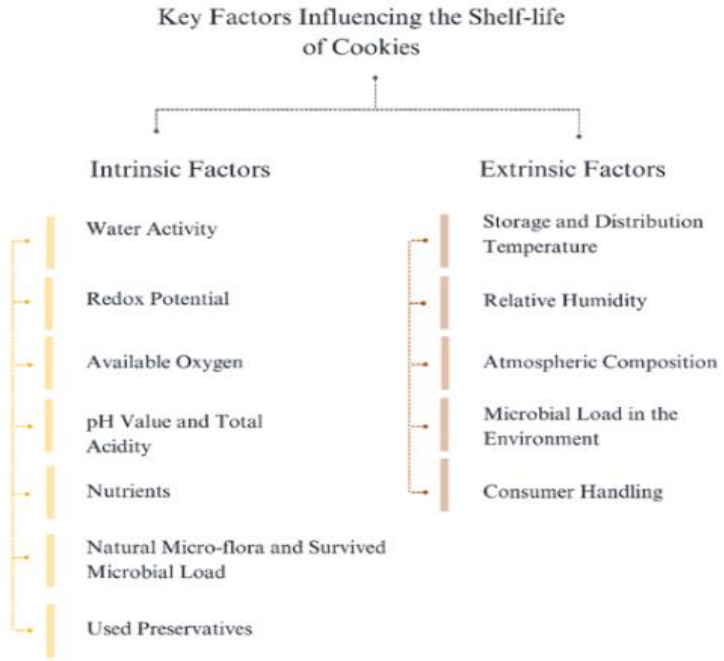

Figure 3. Key factors influencing the shelf life of cookies. This diagram illustrates the intrinsic and extrinsic factors that affect the shelf life of cookies.

6.1. Water activity

Water activity critically affects shelf life. Initial cookie water activity is 0.36±0.02, increasing to 0.57-0.64 during storage [45]. Low water activity limits bacterial spoilage, while xerophilic fungi preferring water activities of 0.65 cause most bakery spoilage [42]. Packaging before proper cooling causes moisture condensation, accelerating mold growth. Water activity changes during transportation and storage depend on packaging permeability, potentially creating favorable microbial environments [46].

6.2. pH value

pH affects microbial growth. Certain yeasts grow at low pH even with lipophilic weak

acid preservatives (benzoic, propionic, sorbic acids) [47]. *Saccharomyces cerevisiae* has an optimum pH of 4.5-4.8 [48] however, molds tolerate pH 3.5-5.5. The combination of low pH and high sugar content in cookies complicates spoilage control [49].

6.3. Storage temperature

Temperature is an extrinsic factor affecting microbial growth. Most mold species responsible for bakery product spoilage grow at 18.3-29.4°C (291.45-302.55 K) [41].

6.4. Nutrient content

Nutrient content intrinsically affects shelf life. *Penicillium verrucosum* and *Aspergillus ochraceus* dominate nutrient-rich environments leading to spoilage [46]. Fat type influences stability whereas in oat-based gluten-free cookies with various fats, saturated fatty acids decreased significantly in lard and palm oil with stearin after six months storage and monounsaturated fatty acids decreased only in hydrogenated palm oil cookies [50]. Fiber source affects the shelf life of cookies with addition of fiber powders reducing moisture content, peroxide value, free fatty acids, and total plate and yeast / mold counts improving shelf stability [51]. Spray-dried eggs reduce cholesterol oxidized products 2.6-fold versus pasteurized eggs [52].

6.5. Natural Microflora and Contamination

Common mold species reported in cookies include *Eurotium amstelodami*, *E. herbariorum*, *E. rubrum*, *Penicillium* sp., *Rhizopus* sp., *Aspergillus flavus*, and *A. niger* [42]. Spoilage yeasts include *S. cerevisiae*, *Zygosaccharomyces bailii*, and *Brettanomyces* spp. acts as a yeast vehicle [48]. *B. subtilis* survives baking with 55% spore retention [41]. Post-baking contamination could occurs via air, handlers, packaging, and equipment [43].

6.6. Organic Acids

Antimicrobial agents (propionic, benzoic, sorbic acids) in formulations or raw materials extend shelf life [53]. Sorbic acid and sorbates are GRAS compounds effective against bacteria, yeasts, and molds. Propionic acid is naturally occurring, though some molds show insensitivity [46].

Shelf life of cookies depends on raw material quality and production processes. Producers could increase shelf life by improving raw material quality and applying optimized processing and packaging methods.

7. Strategies for extending the shelf life of cookies

To extend cookie shelf life, control measures must address microbiological, physical, and chemical spoilage (Table 1).

Table 1. Different control strategies related to spoilage of cookies

Spoilage type	Reason	Control strategy	Examples / details	References
Microbial spoilage	***Moulds*** (Primary cause): *E. amstelodami, E. herbariorum, E. rubrum, Penicillium* sp., *Rhizopus* sp., *A. flavus* and *A. niger* [42] ***Yeasts***: *S. cerevisiae, Z. bailii, B. bruxellensis, B. naardenensis* [48]	Reduced water activity	Spoilage is reduced, microbial growth is reduced and enzymatic and biochemical reactions	[54]
		Maintaining Good Manufacturing Practices	Bakery products can be contaminated with osmophilic yeasts through unclean utensils and equipment. Hence maintaining good manufacturing practices is important to reduce the contamination	[48]
		Before packaging, proper cooling of cookies is needed	To avoid moisture condensation of product's surface and packaging material	[46]
		Cookies can be packed soon after cooling	Contaminations of cookies can be prevented	[46]
		Antimicrobial agents: propionic acid, benzoic acid and sorbic acid can be used	Propionic acid, benzoic acid and sorbic acid are effective for inhibition at pH 4.5 at 0.3% level. Potassium sorbate is effective even at 0.03% level. Also, these antimicrobial agents show their effectiveness mainly at low pH values and sorbates are more effective in yeast inhibition than propionates	[48,53,55]
		Modified atmosphere packaging	To get the enhanced mould free shelf life. The number of used preservatives can be reduced with the usage of modified atmospheric packaging. But	[41,56]

			some microorganisms are not inhibited as moulds at lower oxygen concentration and with the presence of carbon dioxide	
		Hurdle concept	As an example, for using hurdle concept for cookies, applying a combination of slight reduction of water activity, lowering pH value of cookies and incorporating antimicrobial agents can be considered	[57]
Chemical spoilage	Oxidative rancidity and hydrolytic rancidity	Reduce photo oxidation	Metallized packaging films can be used	[39]
		Using a packaging material which has lower permeability to oxygen	To obtain higher oxygen barrier property acrylic coated orientated polypropylene is used for packaging. Modified multilayer polymeric materials can be used to pack cookies with negligible environmental impact. Metalized orientated polypropylene with EVA additive can be used to reduce oxygen migration in to the product. The additive is used as pro-oxidant (EVA-POA) for polymer material	[39]
		Using oxygen absorbers as an active packaging	To reduce increasing the oxygen concentration inside the packaging material during the storage	[38]
		Incorporating natural or synthetic antioxidants	As artificial antioxidants are BHA, BHT, TBHQ, propyl gallate, and ascorbyl palmitate can be used [13]. Cookies produced with spices or herbs showed higher antioxidant activity and phytochemical content compared to cookies produced without inclusion of spices or herbs [58]. Phenolic compounds have redox properties and they can neutralize reactive oxygen species [59]	[13,58,59]
Physical spoilage	Moisture absorption and Moisture loss	Usage of moisture absorbers	To avoid moisture absorption by cookies	[38]
		Usage of proper packaging material which has lower permeability to moisture	Metalized orientated polypropylene with EVA additive can be used to reduce moisture migration in to the product. The additive is used as pro-oxidant (EVA-POA) for polymer material	[39]
		Moisture gradient between the center of the cookies and the edges should be small as much as possible	For that, changing baking conditions of cookies, ensuring even baking and application of radiofrequency or microwave heating coupled with baking can be done. If not, moisture migration can occur from the center of cookies to its edges by leading to breakages of cookie structure	[1]

7.1. Controlling microbial spoilage

Several approaches control microbial growth such as reformulation to reduce water activity, prevention of post-baking contamination, and incorporation of antimicrobial agents. Water activity reduction requires careful attention to maintain organoleptic properties [54].

Organic acid preservatives (propionic, benzoic, sorbic acids) inhibit microbial growth effectively at pH 4.5 and 0.3% concentration; potassium sorbate is effective even at 0.03% [53]. Potassium sorbate is the most suitable preservative for bakery products at pH 4.5 and 0.8 water activity, with 0.3% concentration most effective against fungal spoilage [42,55]. Sorbates inhibit yeast more effectively than propionates; 500 ppm sorbic acid completely prevents spoilage yeast growth at pH 4.25-5.25 [48]. However, effectiveness decreases at higher pH (>5.5) unless water activity is <0.8 [42].

Some yeast species (*Brettanomyces, Saccharomyces, Zygosaccharomyces, Torulaspora*) show genetic adaptation to tolerate weak acid preservatives, necessitating antimicrobial combinations. Triplet combinations prove highly effective,

particularly at pH 3.0. lauric arginate, a novel antimicrobial derived from lauric acid and l-arginine, demonstrates broad-spectrum activity at pH 3-7 [49,57]. The hurdle concept combines multiple factors (temperature, preservatives, water activity, pH) for synergistic microbial control [57].

7.2. Controlling physical spoilage

Physical spoilage control utilizes moisture absorbers [38] and packaging materials with low moisture permeability [39]. Minimizing moisture gradients between cookie centers and edges prevents moisture migration and structural breakage [1].

7.3. Controlling chemical spoilage

Rancidity control strategies include lowering storage temperature, reducing package oxygen concentration, decreasing fatty acid unsaturation, reducing pro-oxidant activity, employing oxygen absorbers, selecting low-oxygen-permeability packaging, and incorporating antioxidants [39].

Natural and synthetic antioxidant incorporation most effectively controls rancidity. Spices and herbs (bay leaves, cinnamon, clove, tarragon, marjoram, mint, oregano, rosemary, sage, thyme) are rich in phenolic acids and flavonoids with high antioxidant potential. Thus, spice and herb inclusion could effectively neutralize reactive oxygen species through redox properties [59]. However, synthetic BHA demonstrates greater effectiveness than herbal extracts with low phenolic/flavonoid content [60].

8. Methods for evaluating cookie shelf life

Shelf life evaluation employs direct methods (real-time studies under actual storage conditions) and indirect methods (accelerated testing and predictive modeling) [61]. Both approaches utilize periodic sampling for sensory (panel or instrumental), physical, chemical, and microbiological analyses (Figure 4) [44].

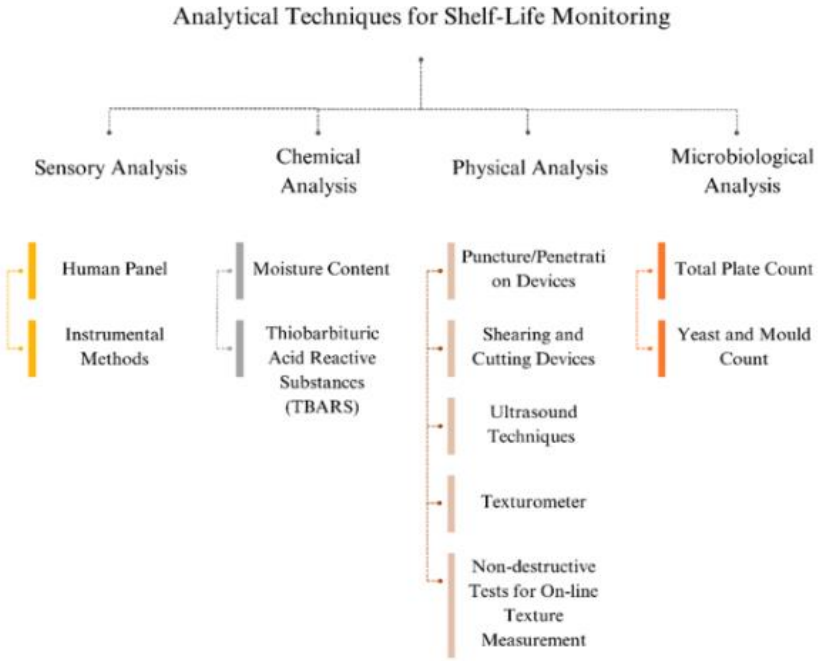

Figure 4. Analytical techniques for shelf life monitoring. This diagram illustrates the sensory, chemical, physical and microbiological analyses commonly used in evaluating the shelf life of cookies.

Sensory analysis measures quality changes most effectively but is expensive and time-consuming. Instrumental methods (computerized texture analyzers, volatile detectors) can substitute if validated against sensory measurements [62].

Measured parameters are compared against maximum allowable limits to determine shelf life. In accelerated shelf life testing (ASLT), elevated stress conditions (temperature, pH, relative humidity) rapidly increase deterioration rates, requiring validated relationships between ambient and accelerated condition. ASLT assumes identical deteriorative processes under both conditions; invalid relationships cause over- or underestimated shelf life predictions. Shelf life determination utilizes Arrhenius and Labuza equations [44].

9. Conclusion

Cookies are subjected to physical, chemical, and microbiological spoilage; therefore, appropriate control measures are needed to extend their shelf life. Various intrinsic and extrinsic factors independently or interactively affect cookie shelf life and accelerate spoilage. Microbiological spoilage is mainly caused by molds (*Eurotium amstelodami, E. herbariorum, E. rubrum, Penicillium* sp., *Rhizopus* sp., *Aspergillus flavus, A. niger*) and yeasts (*Saccharomyces cerevisiae, Zygosaccharomyces bailii, Brettanomyces bruxellensis, B. naardenensis*). Oxidative and hydrolytic rancidity cause chemical spoilage, while moisture absorption and loss cause physical spoilage.

Microbial spoilage control requires reformulating to reduce water activity, ensuring proper cooling before packaging, immediate packaging post-cooling, incorporating antimicrobial agents, maintaining Good Manufacturing Practices (GMP), and preventing post-baking contamination. Physical spoilage control employs moisture absorbers and packaging materials with low moisture permeability. Chemical spoilage control involves lowering storage temperature to reduce lipid oxidation, reducing in-package oxygen concentration, decreasing fatty acid unsaturation, minimizing pro-oxidant activity, using oxygen absorbers, selecting packaging with low oxygen permeability, and incorporating antioxidants.

Cookie shelf life evaluation employ direct methods (real-time studies under actual storage conditions) and indirect methods (accelerated shelf life testing and predictive modeling). Both approaches utilize sensory, physical, chemical, and microbiological analyses of collected samples. Continued research on preservation methods, spoilage factors, smart packaging applications, and digital monitoring techniques will further enhance cookie quality and safety during storage.

Compliance with ethics requirements

Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures respect the specific regulations and standards. Authors declare that they present their own literature survey and results/ discussion/ conclusion in the article.

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