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Effect of Dehydration on the Nutritional Quality, Microbial Safety, and Shelf-Life Extension of Irish Potatoes (*Solanum tuberosum* L.): A Review

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Abstract- Irish potato (Solanum tuberosum L.) ranks among the most strategically important food crops in the world, yet substantial proportions of annual harvests are lost to post-harvest deterioration, particularly in developing countries where refrigeration and cold chain infrastructure remain inaccessible to most smallholder farmers. Dehydration has for centuries been recognised as one of the most practical and cost-effective strategies for extending the shelf life of perishable agricultural commodities, operating by reducing moisture content and water activity to levels at which microbial spoilage, enzymatic browning, and chemical deterioration are effectively suppressed. This paper reviews published evidence on the effects of dehydration on the nutritional composition, microbial safety, sensory attributes, and shelf-life extension potential of Irish potatoes, with attention to the influence of drying method, temperature, pre-treatment, and slice thickness on product quality outcomes. Evidence from the reviewed literature consistently shows that hot air dehydration at 55 to 65 degrees Celsius concentrates carbohydrates, minerals, and B-vitamins on a dry-weight basis, while heat-labile vitamin C undergoes substantial thermal degradation. Antinutritional factors including phytic acid, oxalates, tannins, and protease inhibitors are significantly reduced through thermal denaturation during drying, thereby improving the net nutritional bioavailability of dried products. Microbial load studies confirm that hot air drying at 60 to 70 degrees Celsius reduces total viable counts by 2.5 to 3.0 log units, and that the resulting low water activity prevents microbial re-growth during extended storage. Consumer acceptability studies report overall sensory scores of 7.0 to 8.5 on a nine-point hedonic scale when processing conditions are well controlled. Key research gaps identified include the need for locally grounded dehydration studies using Nigerian potato varieties, long-term tropical shelf-life monitoring, and economic analyses of locally fabricated dehydration equipment for smallholder contexts.

Index Terms- Dehydration; Food Preservation; Hot Air Drying; Irish Potato; Microbial Safety; Nutritional Quality; Post-Harvest Losses; Shelf-Life Extension; Solanum Tuberosum; Water Activity

I. INTRODUCTION

Among the tuber crops that underpin global food security, Irish potato (Solanum tuberosum L.) occupies a uniquely important position. It is currently ranked as the fourth largest food crop in the world by production volume after wheat, rice, and maize, with global output exceeding 375 million metric tonnes annually [1]. More than one billion people rely on the potato as a dietary staple, and the crop is cultivated in over 80 percent of countries worldwide [2]. Beyond its caloric significance, the potato provides complex carbohydrates, good-quality protein, dietary fibre, vitamin C, potassium, and B-vitamins in quantities that make it a meaningful contributor to both macronutrient and micronutrient intake across diverse populations [3, 4].

Despite these attributes, the post-harvest management of Irish potatoes remains deeply problematic across much of the developing world. Fresh tubers contain approximately 75 to 82 percent moisture on a wet weight basis, making them inherently perishable. This high moisture load creates conditions highly conducive to microbial spoilage, weight loss through transpiration, enzymatic browning when tissue is disrupted, and physiological deterioration including sprouting once tuber dormancy naturally terminates [5, 6]. Post-harvest losses in sub-Saharan Africa are particularly severe, with estimates placing losses at 30 to 50 percent of total production depending on region and season [2]. In Nigeria, the problem is compounded by inadequate rural road infrastructure, unreliable electricity supply, limited cold storage capacity, and poor integration of smallholder farmers into formal market value chains [2, 7].

Dehydration is among the oldest and most technically accessible food preservation methods, operating on the principle that removing moisture from a food matrix reduces water activity to levels at which microbial growth, enzymatic reactions, and chemical deterioration are effectively arrested [8]. Compared to refrigeration and more sophisticated emerging technologies such as modified atmosphere packaging or irradiation, dehydration is considerably more accessible in terms of capital cost, energy requirements, and operational simplicity, particularly when implemented using locally designed equipment [9]. This paper reviews and critically synthesises published evidence on the effects of dehydration on the nutritional quality, microbial safety, sensory attributes, and shelf-life extension of Irish potatoes, with attention also to the role of pre-treatment, equipment design, and processing conditions in determining product quality outcomes.

II. NUTRITIONAL COMPOSITION OF FRESH IRISH POTATOES: A BASELINE

Understanding the nutritional baseline of fresh potato tubers is essential for meaningfully interpreting the changes that dehydration induces. Fresh Irish potato tubers typically contain 75 to 82 percent moisture on a wet weight basis, making them nutritionally rich in terms of their dry matter [4]. The dominant macronutrient in the dry matter is starch, constituting approximately 60 to 80 percent of dry weight and composed predominantly of amylopectin and amylose in a ratio of roughly 3:1, though this varies appreciably with cultivar and growing conditions [4]. Total protein content in fresh tubers ranges from 1.5 to 2.5 percent on a fresh weight basis, with the amino acid profile of potato protein broadly well-balanced relative to most other plant foods, comparing favourably with egg protein in nutritional quality [3].

Potatoes are one of the most practically significant dietary sources of vitamin C globally, providing 15 to 30 mg of ascorbic acid per 100 g of fresh edible tuber depending on cultivar and growing conditions [6]. B-vitamins including thiamine, niacin, pantothenic acid, pyridoxine, and folate are also present in nutritionally relevant quantities. Potassium is the dominant mineral in fresh potato tissue, typically provided at 400 to 440 mg per 100 g fresh weight, with phosphorus, magnesium, calcium, iron, zinc, and copper also present [6]. Dietary fibre, including resistant starch and cell wall polysaccharides, contributes additional functional and nutritional value. Antinutritional factors including phytic acid, tannins, oxalates, lectins, and trypsin inhibitors are naturally present in fresh tuber tissue and have implications for the bioavailability of proteins and minerals a pattern well documented across Nigerian staple crops including finger millet [10, 11]. Glycoalkaloids, primarily solanine and chaconine, concentrated in the skin and green-tinted flesh, represent a food safety consideration when tubers are improperly stored or exposed to light [12].

III. POST-HARVEST LOSSES AND THE RATIONALE FOR DEHYDRATION

Post-harvest losses in Irish potatoes are driven by a cluster of interacting biological and infrastructural factors across the value chain. Primary biological drivers include sprouting, which begins as endogenous tuber dormancy terminates and accelerates markedly at elevated ambient temperatures; water loss through the periderm, causing shrivelling and weight shrinkage; enzymatic browning triggered by physical wounding during handling; and microbial decay caused by both bacterial and fungal pathogens [5]. Among microbial agents, bacterial soft rot caused by Pectobacterium carotovorum and related species is consistently identified as the most economically damaging storage disease, as these organisms produce pectinolytic enzymes that rapidly macerate tuber tissue under warm and humid conditions [13]. Glycoalkaloid accumulation, promoted by light exposure and physical damage, further complicates long-term storage and raises food safety concerns [12]. Devaux, Kromann, and Ortiz noted in their review of global potato value chains that in countries including Nigeria, Ethiopia, and Uganda, a combination of inadequate storage infrastructure, poor cold chain access, and weak market linkages means that substantial proportions of the annual harvest never

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reach consumers in edible condition [2]. Makule, Dimoso, and Tassou, reviewing cold storage methods in sub-Saharan Africa, similarly identified the near-total absence of accessible cold chain infrastructure as the dominant structural driver of post-harvest losses for smallholder producers in the region [7]. Processing-based interventions, particularly dehydration, have been increasingly proposed as practical and scalable solutions precisely because they do not require investment in or continuous access to refrigeration infrastructure [9, 14].

IV. OVERVIEW OF DEHYDRATION METHODS APPLICABLE TO IRISH POTATOES

Several dehydration technologies have been evaluated in the published literature for Irish potato and related tuber crop preservation. The selection of an appropriate method involves trade-offs among product quality, capital cost, energy consumption, and operational complexity. Table 1 provides a comparative summary of principal drying methods documented in the reviewed literature.

Table 1: Comparative Overview of Principal Drying Methods Evaluated for Irish Potato and Related Tuber Crops

Drying Method	Key Advantages	Main Limitations	References
Sun/open-air drying	Zero energy cost; widely accessible; no equipment required	Weather-dependent; contamination risk; poor product uniformity	[14, 15]
Hot air convective drying	Controlled conditions; consistent; scalable; well-studied	Energy intensive; vitamin C losses increase above 55 degrees C	[9, 14, 16]
Freeze-drying	Excellent nutrient and colour retention; best rehydration quality	Very high capital and operating cost; impractical for smallholders	[17, 18]
Microwave drying	Rapid moisture removal; potentially energy efficient	Uneven heating risk; high equipment cost; textural defects at high power	[19]
Osmotic dehydration	Low-temperature processing; good sensory quality; low energy demand	Partial dehydration only; requires a complementary drying step	[20]
Vacuum drying	Low temperature operation; good retention of bioactive compounds	High equipment cost; limited accessibility in low-resource settings	[21]

Note: Compiled from reviewed literature. References indicate primary studies where each method has been evaluated in relation to potato or comparable tuber crops.

Among these methods, hot air convective drying has consistently been identified as the most practical and cost-effective option for small and medium-scale Irish potato preservation in developing countries. Bhattacharjee et al. [9], in a critical review of food drying technologies, noted that hot air drying remains the dominant small-scale and industrial drying technology globally, owing to its adaptability across a wide range of food products and scales of operation. Rashid et al. [14], in a systematic review of energy-efficient drying technologies applied to sweet potato a crop with broadly analogous moisture content, starch composition, and cellular structure to Irish potato concluded that forced convection hot air drying at 55 to 65 degrees Celsius represents the optimal practical combination of nutritional retention, sensory quality, energy efficiency, and microbial safety. Freeze-drying produces the highest-quality dried products from a nutritional standpoint but requires capital and operating costs that place it entirely beyond reach for smallholder operations in Nigeria or comparable developing-country settings [17]. Ando and Nei [18] demonstrated that air-drying, freeze-drying, and microwave-vacuum drying produce potato powders with distinct structural and physical properties, with freeze-dried powders showing superior rehydration characteristics but with no practical advantage for staple food preservation at the farm level.

V. EFFECT OF DEHYDRATION ON NUTRITIONAL QUALITY OF IRISH POTATOES

Proximate Composition

The effect of dehydration on proximate composition of Irish potatoes is well-documented, and the collective evidence consistently points to a concentration effect for most nutrients when expressed on a wet weight basis following moisture removal. As moisture content falls from the typical fresh-tuber range of 75 to 82 percent to the dried-product range of 8 to 18 percent, the remaining constituents are mathematically concentrated in proportion to the degree of drying achieved. Total carbohydrate content increases from approximately 10 to 20 percent in fresh tubers to 70 to 85 percent in well-dried products on a wet weight basis, a change primarily attributable to moisture removal rather than carbohydrate synthesis [14]. Crude protein concentration increases similarly from below 2.5 percent in fresh tubers to 4 to 8 percent on a dry weight basis following dehydration, reflecting concentration of existing protein content rather than new synthesis. Ash content increases substantially in proportion to moisture reduction.

Crude fat content, inherently very low at 0.1 to 0.2 percent of fresh weight, increases proportionally on a dry weight basis following drying. Crude fibre has been reported to increase in dehydrated potato and related tuber products, partly through moisture removal and partly through structural modifications to cell wall polysaccharides during thermal processing. Singh et al. [22] documented significant increases in crude fibre concentration on a dry weight basis following hot air drying at 60 degrees Celsius in Irish potato slices, and found that drying temperature and airflow rate interacted significantly in determining the final proximate profile. The energy value per 100 g of dried product increases substantially relative to fresh weight owing to the combined concentration of energy-yielding macronutrients, with important implications for the nutritional labelling of dehydrated potato products. The same mineral concentration dynamics upon processing were documented by Okwori et al. [10] for finger millet from northern Plateau State, Nigeria, where mineral densities increased appreciably following processing, a pattern wholly consistent with what the dehydration literature records for Irish potato.

Vitamin Content

The degradation of heat-labile vitamins, particularly ascorbic acid, has received the most consistent attention in the Irish potato processing literature. Vitamin C is both water-soluble and thermosensitive, susceptible to degradation by heat, oxygen, metal ions, light, and alkaline pH, making it among the most vulnerable nutrients in any thermal processing operation. The degradation of ascorbic acid during hot air drying of potato slices follows first-order kinetics, with the rate constant increasing exponentially with drying temperature consistent with the Arrhenius relationship [23]. Studies on hot air drying of potato and related tubers have documented vitamin C losses ranging from 30 to 70 percent relative to fresh tissue, with losses increasing progressively with both drying temperature and duration of thermal exposure [14]. Blanching as a pre-treatment, while essential for inactivating polyphenol oxidase and maintaining product colour, contributes additional ascorbic acid loss through leaching into the blanch water, compounding the thermal losses that occur during subsequent drying.

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B-vitamins, by contrast, are considerably more thermostable than ascorbic acid and respond quite differently to the dehydration process. Thiamine, niacin, pantothenic acid, and pyridoxine are present in fresh potato tissue and, on a dry weight basis, their concentrations generally increase following dehydration, reflecting the concentration of existing vitamin content as moisture is removed rather than any new synthesis [3]. The practical implication is that dehydrated potato products, despite their unavoidable vitamin C losses, can represent a meaningfully concentrated source of B-vitamins, particularly when consumed in rehydrated form as part of a varied diet. Carotenoid content, relevant especially in yellow-fleshed potato varieties, has been reported to be reasonably well retained by hot air drying at temperatures below 60 degrees Celsius, though oxidative degradation accelerates at higher operating temperatures [14]. Table 2 summarises key findings from verified published studies on the effect of drying conditions on vitamins in potato and analogous crops.

Table 2: Reported Effects of Hot Air-Drying Conditions on Vitamin Content of Potato and Analogous Tuber Crops

Study	Crop	Drying Conditions	Vitamin C Outcome	B-Vitamin Trend
Rashid et al. [14]	Sweet potato	55-65 degrees C; forced convection	35 to 55% loss	Increased on dry weight basis
Singh et al. [22]	Irish potato	60 degrees C; RSM-optimised	Significant loss documented	Concentration effect observed
Bhatta et al. [17]	Plant-based foods	Freeze-drying vs. hot air	Substantially lower loss in freeze-drying	Retained in both methods
Ando and Nei [18]	Potato	Air, freeze, microwave-vacuum	Air-drying showed highest loss	Not separately reported
Hassan et al. [23]	Date plum (analogous)	Various hot air temperatures	First-order degradation kinetics confirmed	More thermostable than vitamin C

Note: RSM = Response Surface Methodology. Vitamin C losses expressed relative to fresh tissue on a wet weight basis. Source: Compiled from cited studies.

Mineral Composition

Minerals are thermally stable inorganic elements that are not degraded at temperatures used in conventional hot air drying, and their concentrations in dehydrated potato products are therefore governed primarily by the mathematics of moisture removal rather than any thermal chemistry. Potassium, the dominant mineral in Irish potato tissue, increases substantially in dried products simply because the same absolute mineral quantity is distributed across a much smaller mass of dehydrated tissue [6]. Phosphorus, magnesium, calcium, iron, zinc, copper, and sodium exhibit comparable proportional increases as expected from dry matter concentration following moisture loss. This concentration effect has clear practical nutritional significance, as dehydrated potato products can be meaningfully mineral-dense per unit weight compared to their fresh equivalents. However, aqueous pre-treatments such as blanching can result in some leaching of water-soluble minerals, particularly potassium, into the processing water, and this must be taken into account when reporting the net mineral content of finished dehydrated products. The same mineral concentration dynamics are illustrated by Okwori et al. [10], who documented significant increases in mineral density in processed finger millet from northern Plateau State, Nigeria, a pattern directly analogous to what the dehydration literature records for Irish potato.

Antinutritional Factors

Antinutritional factors naturally present in Irish potatoes, including phytic acid, tannins, oxalates, lectins, and trypsin inhibitors, reduce the net bioavailability of proteins and minerals through complexation with nutrients and inhibition of digestive enzyme activity [11]. Research consistently demonstrates that thermal processing, including hot air dehydration at temperatures above 50 degrees Celsius, significantly reduces the concentrations of these antinutrients through heat denaturation, hydrolysis, and solubilisation into processing water during aqueous pre-treatments [11]. Blanching is particularly effective in reducing heat-labile lectins and trypsin inhibitors, while phytic acid and oxalate reductions are primarily attributable to hydrolysis and dissolution during aqueous heating. The net practical consequence is improved bioavailability of protein and minerals in the dehydrated product compared to the raw fresh tuber, partially compensating nutritionally for vitamin C losses that unavoidably occur during thermal drying. This makes the net nutritional impact of dehydration on potato quality more nuanced and context-dependent than a simple focus on vitamin C alone would suggest.

VI. EFFECT OF DEHYDRATION ON MICROBIAL SAFETY AND SHELF-LIFE EXTENSION

Dehydration preserves Irish potatoes through two distinct but mutually reinforcing antimicrobial mechanisms: thermal inactivation of vegetative microbial cells during the active drying phase, and suppression of residual microbial activity through reduction of water activity in the finished product to levels below the minimum thresholds required for microbial growth and reproduction [8]. Together, these mechanisms provide durable microbial stability to properly dried and packaged food products.

Fresh Irish potato surfaces carry total viable bacterial counts of 4.0 to 5.0 log CFU/g and yeast and mould populations of 3.5 to 4.0 log CFU/g, reflecting contamination accumulated during field production and post-harvest handling under non-sterile conditions [13]. Hot air drying at 60 to 70 degrees Celsius has been shown to reduce total viable counts to below 2.0 log CFU/g and yeast and mould counts to below 1.5 log CFU/g, representing reductions of 2.5 to 3.0 log units from initial fresh-tuber counts [24]. These reductions are sufficient to substantially reduce the risk of both foodborne illness and microbial spoilage in the dried product during subsequent storage. Heat-resistant bacterial endospores, particularly those of Bacillus cereus and Clostridium spp., may survive conventional hot air-drying temperatures; however, their germination and growth are effectively inhibited by the low water activity of properly dried products, provided moisture reabsorption during storage is prevented by appropriate packaging [8]. Adeyeye et al. [24] demonstrated that potato products dehydrated to below 10 percent moisture content and packaged in sealed polyethylene bags maintained total viable counts below 2.0 log CFU/g and yeast and mould counts below 1.0 log CFU/g throughout six months of ambient tropical storage in Nigeria, confirming the practical shelf-life extension achievable through the combination of dehydration and appropriate packaging.

The importance of hygienic handling practices during post-drying operations cannot be overstated, since contamination introduced during slicing, tray loading, and packaging can substantially erode the microbial safety gains achieved through the drying process itself. Rashid et al. [14] and Mugodo [25], studying sweet potato drying, both highlighted the critical importance of clean equipment surfaces, well-ventilated processing environments, and airtight packaging materials in sustaining the microbial stability of dried products throughout their intended storage lives. These principles apply with equal force to Irish potato dehydration and are fundamental to any quality assurance framework for producing shelf-stable dehydrated potato products under smallholder conditions.

VII. INFLUENCE OF PRE-TREATMENT AND PROCESSING PARAMETERS ON QUALITY

Pre-treatment of potato slices prior to drying is among the most practically important factors determining the quality of the final dehydrated product. The most widely applied pre-treatment is blanching, which involves brief immersion of sliced potato tissue in boiling water or exposure to steam for 2 to 5 minutes. The primary purpose of blanching is to inactivate polyphenol oxidase and peroxidase, the enzymes responsible for enzymatic browning that produces undesirable dark pigmentation when potato tissue is cut or exposed to oxygen [16]. Blanched potato slices consistently exhibit significantly better colour retention following dehydration than unblanched controls, with the quality difference becoming more pronounced at higher drying temperatures where the Maillard reaction between reducing sugars and free amino acids simultaneously contributes additional browning. Blanching also reduces the initial surface microbial load on fresh slices and partially gelatinises surface starch, improving both the rehydration characteristics and the final appearance of the reconstituted product [16].

Citric acid pre-treatment is a widely reported complementary anti-browning strategy, typically applied as an immersion in a 0.5 to 1.0 percent solution for 5 to 10 minutes prior to drying. Boateng [26] reported that citric acid pre-soaking significantly maintained lightness values in treated potato slices and meaningfully improved overall sensory acceptability, functioning both as a competitive inhibitor of polyphenol oxidase and as an acidulant that lowers pH to levels at which enzyme activity is markedly reduced. Pulsed electric field pre-treatment, reviewed by Bhattacharjee et al. [9] among emerging drying pre-treatments, has shown potential to reduce total drying time by improving moisture transport through the potato cellular matrix while simultaneously improving vitamin C retention relative to conventional hot air drying alone, though this technology is not yet accessible at the smallholder scale.

Slice thickness is another pre-drying variable with substantial influence on drying kinetics and product uniformity. Thinner slices expose a greater surface area relative to their volume, facilitating faster moisture removal and more consistent final moisture content across the product batch. Xiao et al. [16] confirmed that thinner product sections dried significantly more quickly than thicker ones and recommended slice thicknesses of 3 to 7 mm for potato dehydration depending on drying temperature and equipment design. Singh et al. [22], applying Response Surface Methodology to Irish potato dehydration, identified slice thickness as a statistically significant predictor of both drying time and colour quality, confirming that pre-treatment and processing parameters must be considered as an integrated system rather than as isolated independent variables.

VIII. SENSORY PROPERTIES AND CONSUMER ACCEPTABILITY OF DEHYDRATED IRISH POTATOES

The consumer acceptability of dehydrated potato products is determined by a combination of sensory properties of which colour, texture, flavour, and aroma are the most influential. Colour is frequently the first attribute that consumers evaluate and effectively shapes purchase intentions before any other sensory dimension can be experienced. The two primary colour-change mechanisms during drying of potato slices are enzymatic browning mediated by polyphenol oxidase acting on chlorogenic acid and other phenolic substrates, and the non-enzymatic Maillard reaction between reducing sugars and free amino acids, both intensifying at higher drying temperatures and longer drying durations [27]. Both mechanisms are substantially suppressed by effective blanching and citric acid pre-treatment, explaining why pre-treated potato slices consistently achieve better colour scores compared to untreated controls.

The textural characteristics of the dried product, including hardness, crispness, and fracturability, are strongly shaped by drying temperature and the final moisture content achieved. Boateng [26] reported that hot air dehydration at 55 to 65 degrees Celsius with appropriate pre-treatment produced potato slices with acceptable to good texture and crispness in sensory evaluations, while drying above 70 degrees Celsius was associated with excessive case hardening and brittleness that panellists consistently rated negatively. The relationship between drying temperature and final texture is therefore practically critical: too low a temperature yields inadequately dry, soft products, while too high a temperature results in hard, brittle, or case-hardened products with poor rehydration quality and reduced acceptability.

Consumer acceptability studies on hot air dehydrated potato products have generally reported overall

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sensory scores of 7.0 to 8.5 on a nine-point hedonic scale when drying is conducted at 55 to 65 degrees Celsius with appropriate pre-treatment, representing strong consumer acceptance under well-controlled processing conditions [22, 26]. Adeyeye et al. [24], assessing dehydrated potato products produced under small-scale processing conditions in Nigeria, reported that products dried to below 10 percent moisture with blanching pre-treatment maintained acceptable colour, texture, and flavour attributes after six months of ambient storage, confirming the practical viability of dehydration as a shelf-life extension strategy in the Nigerian context.

IX. ELECTRICAL DEHYDRATOR DESIGN FOR SMALLHOLDER CONTEXTS

A growing body of published research has focused on the design, fabrication, and performance evaluation of electrical dehydrators adapted for Irish potato and related tuber crops under smallholder conditions in developing countries. Inyang, Oboh, and Etuk [15], reviewing drying technologies applicable to tropical food products, noted that locally designed electrical dehydrators offer substantially better control over drying temperature, airflow, and product hygiene compared to traditional open-air and solar drying methods. Bhattacharjee et al. [9] similarly identified locally fabricated forced-air cabinet dryers as the most appropriate technology tier for smallholder food processing in low-income countries, noting that they can achieve performance broadly comparable to commercial imported units at substantially lower procurement cost when designed with appropriate engineering knowledge.

Critical design parameters for any functional electrical dehydrator include uniform temperature and airflow distribution across all drying trays, adequate chamber insulation to minimise heat losses, safe clearance between heating elements and structural materials, easy-access removable trays with perforated surfaces to promote airflow, and reliable temperature control to prevent thermal overshoot [28]. The Energy Efficiency Ratio defined as the ratio of useful energy applied to moisture evaporation to total electrical energy consumed during a drying cycle provides a standardised metric for evaluating and comparing dehydrator performance across different designs [29]. Strategies for improving this ratio include optimising chamber insulation, using variable-speed fans, and implementing closed-loop PID temperature control that prevents unnecessary heating cycles [28]. Xiao et al. [16] noted that tray design and spacing within multi-tray dehydrators significantly influence airflow uniformity around the product, and that poorly designed tray arrangements produce substantial variation in drying rate across the batch, leading to non-uniform final moisture content with implications for both product safety and quality.

X. RESEARCH GAPS AND DIRECTIONS FOR FUTURE WORK

The review of published literature reveals several significant gaps that limit the direct translation of existing knowledge into practical post-harvest solutions for smallholder farmers in Nigeria and West Africa. The most conspicuous gap is geographic. The great majority of published studies on Irish potato dehydration have been conducted in Asia, Europe, and North America, using cultivars and under climatic conditions that may differ substantially from those relevant to Nigerian producers. The specific drying behaviour, nutritional response to dehydration, and sensory characteristics of Irish potato varieties commercially cultivated in Benue, Plateau, and Kaduna States remain poorly characterised in the published literature. There is a clear and pressing need for locally grounded dehydration studies using Nigerian variety germplasm under actual field and processing-facility conditions rather than extrapolated from laboratory findings produced in very different environments.

Second, most studies in the reviewed literature have monitored product quality over relatively short periods of three to six months under controlled laboratory conditions, providing limited evidence on the actual shelf life achievable under real-world ambient storage conditions in Nigerian rural markets and households. Long-term shelf-life monitoring studies tracking changes in nutritional quality, microbial safety, and sensory attributes over nine to twelve months under tropical ambient conditions are needed to provide farmers and traders with reliable, evidence-based guidance on the practical storage life of locally produced dehydrated potato. Third, while the engineering literature contains design and performance data on locally fabricated dehydrators [28], there is limited published evidence on the cost-benefit dynamics from the perspective of Nigerian smallholder farmers, including break-even analysis, return on investment timelines, and market development potential for dehydrated Irish potato products in Nigerian urban and peri-urban markets.

XI. CONCLUSION

This review has synthesised published evidence on the effects of dehydration on the nutritional quality, microbial safety, sensory attributes, and shelf-life extension potential of Irish potatoes. The weight of evidence is clear: properly executed hot air drying, conducted at 55 to 65 degrees Celsius with appropriate pre-treatment such as blanching or citric acid immersion, is highly effective at extending shelf life by months, substantially reducing microbial loads, concentrating macro and micronutrients on a dry-weight basis, reducing antinutritional factors, and producing dried products with consumer acceptability ratings well within commercially and nutritionally viable ranges. The primary nutritional trade-off is the thermal degradation of vitamin C, which is unavoidable at temperatures required for effective microbial inactivation and moisture reduction, but which can be partially mitigated through careful optimisation of drying temperature, duration, and pre-treatment approach.

Dehydration represents a particularly compelling intervention in the context of Nigerian and sub-Saharan African smallholder farming systems, where cold chain infrastructure is largely absent and post-harvest losses are severe and well-documented. The literature on locally fabricated electrical dehydrators confirms that affordable and functionally effective equipment can be constructed from locally available materials with performance that compares favourably to commercially imported alternatives. Realising this potential at scale requires continued technical research to optimise dehydration parameters for locally relevant potato varieties and processing conditions, as well as sustained attention to the socioeconomic, infrastructure, and policy dimensions that ultimately determine whether post-harvest technology uptake achieves meaningful impact in rural farming communities.

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