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RESEARCH ARTICLE

OPTIMIZATION AND CHARACTERIZATION OF OVEN-DRIED YACON (SMALLANTHUSSONCHIFOLIUS) POWDER JUICE: PHYSICOCHEMICAL PROPERTIES, STRUCTURAL INTEGRITY, AND POTENTIAL AS A FUNCTIONAL FOOD INGREDIENT

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Abstract

This study focused on optimizing oven-drying conditions to preserve bioactive compounds, particularly fructooligosaccharides (FOS), in yacon (Smallanthussonchifolius) root powder, while ensuring desirable physicochemical characteristics. Different drying temperatures (60°C, 70°C, and 80°C) and durations (6 to 12 hours) were evaluated. The results showed that drying at 60°C for approximately 8–10 hours was optimal, achieving a balance between energy efficiency and the retentio n of bioactive compounds. The yacon powder juice had moisture conte nts below 6% and water activity levels suitable for long-term stability and microbial safety. The FOS content was well-preserved under these conditions, and FTIR spectroscopy confirmed the structural integrity of key carbohydrate components such as soluble starches and FOS. Based on its moisture content, water activity, and pH, these powders were found to be appropriate for usage in nutritional supplements and functional meals. The production of high-quality yacon powder that preserved its nutritional and prebiotic qualities was accomplished using regulated moderate-temperature oven drying, underscoring the promise of this food product as a health promoting ingredient.Overall, generatin g high quality yacon powder while preserving its nutritional and prebiot ic qualities through regulated moderate temperature oven drying reveal ed the plants potential as a health-promoting ingredient in a variety of food dishes as well as can be used as a supplemental food.

Introduction:-

Background of the Study:-

The world population is rapidly increasing, and this requires a greater supply of food. Therefore, boosting the productivity of the food industry is crucial to meet the demand and provide enough food for everyone. Thus, increasing food industry productivity is a significant factor to provide a proper number of foods to world population. Humans want to use natural resources. At present, it is necessary to explore innovative methods for utilizing natural resources to their maximum potential. They tend to be creative, tried to modify and enhanced the available raw materials from "farm to table" or into functional foods.

Yacon (Smallanthussonchifolius) is a root crop that has a sweet taste due to its abundance of soluble carbohydrates, including fructooligosaccharide (FOS), which contains a low glycemic index, and rich nutritional value. Despite its potential as a functional food, yacon remains underutilized in the Philippines, especially in processed forms such as powder juice.

According to the study of Sebhatu et al., (1994), fruit juice powders obtained by drying the extracted juice to produce solids with elevated sugar content, which are mainly present in the amorphous state. The production of fruit juice powder involves a sophisticated process designed to preserve the nutritional value, flavor, and aroma of fresh fruit juice while significantly extending its shelf life. Typically, this is achieved through spray drying, freeze-drying methods, microencapsulation through extrusion, and even using an oven-drying methods, which remove moisture content without compromising the integrity of essential nutrients. These techniques result in a fine, stable powder that can be easily reconstituted with water. Powdered juice offers a convenient, lightweight, and cost-effective alternative to liquid beverages, making it ideal for broad distribution, especially in regions with limited refrigeration. Moreover, by eliminating the need for artificial preservatives and reducing exposure to chemical additives commonly found in commercial drinks, fruit juice powder serves as a healthier option suitable for all age groups, particularly children. Its compact form also ensures easier storage, transport, and longer shelf stability, which is beneficial in both commercial and emergency nutrition contexts.

The drying methods depend on the desired product attributes. Spray drying is advantageous as compared to freeze drying and oven drying, for its efficiency and cost-effectiveness, suitable for large-scale production. Freeze drying, albeit more expensive, is preferable when the preservation of nutritional and sensory qualities is paramount. Both methods contribute to reducing food waste and enhancing the accessibility of fruit-based nutrients, particularly benefiting populations with limited access to fresh produce. Oven drying is a relatively simple and accessible method used in the production of fruit juice powder, particularly in small-scale or experimental setups. This technique involves spreading fruit juice concentrate or fruit pulp in thin layers on trays and subjecting it to controlled heat in a convection oven, typically at temperatures ranging from 50°C to 70°C.

The process relies on hot air to evaporate moisture from the product over an extended period, which can range from several hours to a full day depending on the fruit type and moisture content. Although oven drying is less efficient and slower than spray or freeze drying, it is cost-effective and requires minimal specialized equipment. According to Parikh et al., (2015), oven drying can retain a reasonable amount of nutrients such as vitamin C and antioxidants, although prolonged exposure to heat may degrade heat-sensitive compounds. Moreover, the resulting powder may exhibit differences in solubility and texture compared to powders produced through more advanced drying techniques. Despite these limitations, oven drying remains a practical method for the development of natural fruit juice powders, particularly in local or artisanal production contexts.

The production of powdered fruit juice is a pivotal advancement in food preservation, aiming to extend shelf life while retaining nutritional and sensory qualities. Two primary techniques employed are spray drying and freeze drying. Spray drying involves atomizing fruit juice into a hot air chamber, rapidly removing moisture and yielding a fine powder. This method is cost-effective and scalable, making it suitable for industrial applications. The addition of carrier agents like maltodextrin and glucose syrup, ascorbic acid, vitamin C significantly influences the quality of the resulting powder, affecting factors such as moisture content and rehydration time was also used in the production of a fruit juice powder.

To maintain its bioactive components and produce a stable, high-quality powdered product, this study highlights the significance of optimizing drying techniques, particularly oven drying. Since it affects basic characteristics like moisture content, water activity, pH level, and the material's overall structural integrity, effective dehydration is crucial. The powder's shelf life, microbiological safety, solubility, and sensory appeal are all influenced by these variables taken together.

By analyzing the behavior of its bioactive components, physicochemical characteristics, and structural composition after processing, the study also investigates the potential of yacon (Smallanthussonchifolius) as a functional food ingredient. Preserving the structure of carbohydrate matrices, such as fructooligosachirides (FOS) and soluble starches, is essential to maintaining the powder's prebiotic and functional qualities. This study highlights the significance of optimizing drying techniques, particularly oven drying, to preserve bioactive components and create a stable, high-quality powdered product. Effective dehydration is essential because it impacts fundamental properties like moisture content, water activity, pH level, and the general integrity of the material.

The study also expands on previous research that emphasizes the significance of preserving low moisture content (less than 6%) and low water activity to prevent microbiological activity, enzymatic deterioration, clumping, and nutritional loss while in storage. The goal of the research is to create yacon powder that maintains its nutritional content and functional properties so that it may be used in nutraceutical formulations and meals that promote health by optimizing drying parameters like temperature and duration.

Lastly, the study emphasizes the wider applicability of these functional powders in the production of food products with a health focus, especially those that contain probiotics. Probiotic viability and lifespan over the course of the product's storage life are greatly influenced by low moisture levels.

Objectives of the Study

This study developed an oven dried yacon powder juice. Specifically, the study sought answers to the following questions:

1. To characterize the molecular structure and functional groups of oven-dried yacon powder using Fourier Transform Infrared Spectroscopy (FTIR).
2. To determine the physicochemical properties of the yaconpowder,in terms of:

a. Moisture content;
b. Water activity;
c. ph level;

REVIEW OF RELATED LITERATURE

CHARACTERISTICS OF YACON POWDER

The tuberous roots of the Yacon plant, which is prized for its excellent nutritional profile, low glycaemic index, and high fructooligosaccharide (FOS) content, are used to make Yacon powder (Smallanthussonchifolius). The high concentration of inulin-type prebiotics in the powder gives it a naturally sweet flavour and a fine, hygroscopic texture. "Physicochemically, a yacon powder usually exhibits low moisture content (below 6%) and reduced water activity (aw < 0.5), which contribute to its extended shelf life and microbial stability," according to Lago et al. (2021),as cited by Silva et al. (2022).

According to a study by Parikh et al. (2015), yacon powder retains important bioactive compoundslike antioxidants and dietary fibres when oven-dried at regulated temperatures (50–70°C). However, extended heat exposure may marginally degrade heat-sensitive nutrients like vitamin C. The use of reconstituted Yacon powder in functional beverages is further supported by its low acidity (pH 5.3–5.5), which promotes gastrointestinal health and microbial compatibility. It can also be used in low-calorie sweeteners, vitamins, and health meals due to its palatability and solubility. Yacon powder's potential as a value-added ingredient in the nutraceutical and functional food industries is highlighted by its physical and chemical characteristics as well as its functional advantages.

Powder (https://www.rocketrobin.ca/product/yacon-root-powder). Retrieved May 10, 2025.

Nutritive Value of Yacon Powder

Fructooligosaccharides (FOS), a form of prebiotic fibre that supports gut health by promoting the growth of good intestinal bacteria like Lactobacillus and Bifidobacterium, are one of the high nutritional value of yacon powder (Genta et al., 2009). Yacon has a low glycaemic index, which makes it advantageous for those with diabetes and those watching their weight because it has less starch than other root crops and most of its carbohydrates are made up of inulin-type oligosaccharides, which are indigestible.

Yacon powder also contains antioxidants, polyphenols, and vital minerals like potassium, calcium, and phosphorus, according to Lago et al. (2012). It also contains trace amounts of vitamin C, which adds to its antioxidant activity, though heat processing may partially degrade this nutrient(Silva et al.,2022).In addition to being a natural sweetener, yacon powder is also a functional dietary ingredient that may help control blood sugar, improve digestion, and boost immunity. It is processed using drying techniques that preserve its beneficial compounds. Because of these qualities, it can be included in dietary supplements, functional drinks, and nutraceuticals that support digestive and metabolic health.

Nutritional Composition of YaconExtracted Juice Converted into Powder

The conversion of Yacon (Smallanthussonchifolius) juice into powder through drying techniques, particularly oven drying, preserves many of the root's original bioactive and nutritional components. The yacon powder typically contains high levels of fructooligosaccharides (FOS)ranging from 30% to 50% of total dry weight in making it a potent prebiotic food source (Campos et al., 2012). It also retains simple sugars such as glucose, fructose, and sucrose in smaller quantities, contributing to its naturally sweet flavor while maintaining a low glycemic index. Nutritionally, Yacon powder provides dietary fiber (5–10%), potassium (250–400 mg/100g), calcium, phosphorus, and iron, and modest amounts of vitamin C and polyphenols, which offer antioxidant benefits as cited by (Lago et al., (2012). Although some nutrient lossespecially vitamin C, can occur during heat exposure in oven drying, the final powder still offers considerable nutritional density. The moisture content of the powder typically ranges from 4–6%, supporting microbial safety and shelf life, while water activity values below 0.5 further preserve nutritional quality (Silva et al., 2022). Overall, Yacon juice powder is not only a functional sweetener but also a valuable dietary component with digestive, metabolic, and antioxidative health benefits.

Fourier Transform Infrared Spectroscopy (FTIR)

Fourier Transform Infrared (FTIR) spectroscopy serves as a valuable analytical tool for identifying and analyzing functional groups and molecular structures within food components, particularly carbohydrates like those present in yacon powder. FTIR creates a distinct spectral signature that indicates the existence and state of chemical groups by identifying the way molecular bonds absorb infrared light.

The use of FTIR provides a crucial role in confirming that significant carbohydrate structures such fructooligosaccharides (FOS) and soluble starch are retained in oven-dried yacon powder. The key molecular vibrations are indicated by peaks in the FTIR spectrum, such as O–H stretching around 3300 cm^{-1} (related to sugars' hydroxyl groups), C–H stretches around 2900 cm^{-1} (related to an aliphatic chains), and C–O/C–C expanding between 1000 and 1200 cm^{-1} (which indicates the carbohydrate backbone). Other spectrum characteristics can indicate processing-induced changes or indicate the presence of specific oligosaccharides.

The integrity of carbohydrate matrices is preserved by carefully regulated oven-drying, as seen by the substantial similarity or purity index (e.g., 0.9870) among oven-dried samples and samples dried using different methods, which suggests little structural damage. The powder's functional properties, like as its prebiotic and health-promoting actions, depend on this preservation.

All things considered, FTIR is a vital quality control method for identifying when drying and processing circumstances have changed the structure of the molecules, in addition to verifying the existence of carbohydrate structures. It is beneficial to keep these structures intact.

Materials and Methods:-

Materials/Equipment Used

The ingredients used in preparing the yacon powder juice includes yacon powder, powdered sugar, tricalcium phosphate, ascorbic acid, citric acid, and powdered sugar.

The tools and materials employed in the process consisted of a mesh, measuring scoop, spatula, ring clamp stand, iron retort stand with burette clamp, weighing scale, zip lock, funnel glass, rubber band, and polyethylene plastic sachets for packaging. All materials and tools were properly washed and sanitized prior to use, then air-dried and arranged systematically to facilitate the preparation process. The equipment used was a sealing machine.

Research Design

In the experimental procedure, the research design involved systematic experimentation using Response Surface Methodology (RSM) to determine the optimal oven-drying conditions that preserved the quality and bioactive compounds of yacon. A factorial experimental design was initially conducted to examine the effects of drying temperature and duration at different levels. Based on the preliminary results, a Central Composite Design (CCD) was implemented within RSM to develop a quadratic model describing the relationships between the variables and responses such as moisture content, water activity, pH level, retention of FOS and other bioactive compounds.

The preparation of yacon powder juice followed these steps: ingredients were prepared and mixed until a homogenous powder mixture was obtained, then poured into sealed plastic pouches with an acceptable water volume (50 ml). The pouches were sealed by dipping into a sealing machine set at 150–180°C for 1–2 seconds.

For the drying process, the oven-drying was carried out by precisely controlling the temperature and time as per the experimental matrix. The physicochemical properties of the dried yacon powder, including moisture content, water activity, particle size distribution, structural integrity, and functional groups, were analyzed. Moisture content was determined through gravimetric analysis, water activity was measured using a water activity meter, and particle size distribution was assessed through sieving. Structural integrity and carbohydrate functional groups were evaluated using FTIR spectroscopy.

Statistical analysis, including ANOVA, was performed to identify significant effects, and regression models were developed to describe the responses. The optimization of drying conditions was achieved through RSM to maximize bioactivity and quality attributes, culminating in the establishment of optimal parameters for high-quality yacon powder production.

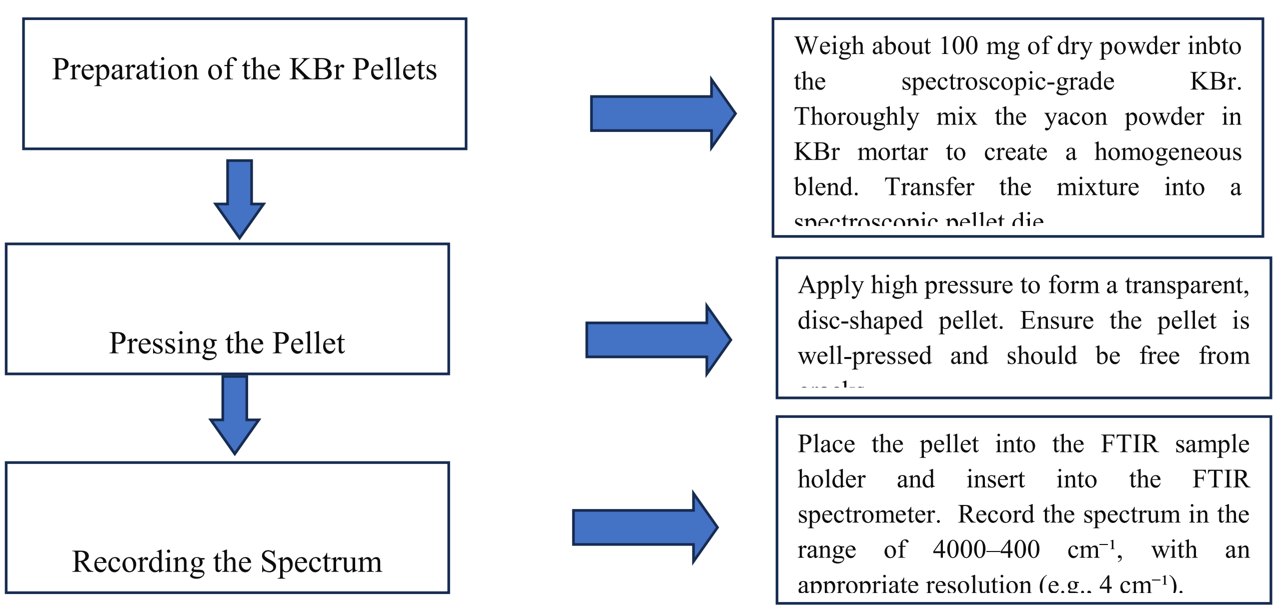
Locale of the Study

This study was conducted at the Institute of Food Research Development- Kasetsart University, Thailand and at locos Sur Polytechnic State College, Sta. Maria, Ilocos Sur last April- May, 2025.

Data Gathering Procedures

EXPERIMENTAL PROCEDURE YACON POWDER JUICE

PROCESS **PROCEDURAL LIMIT**

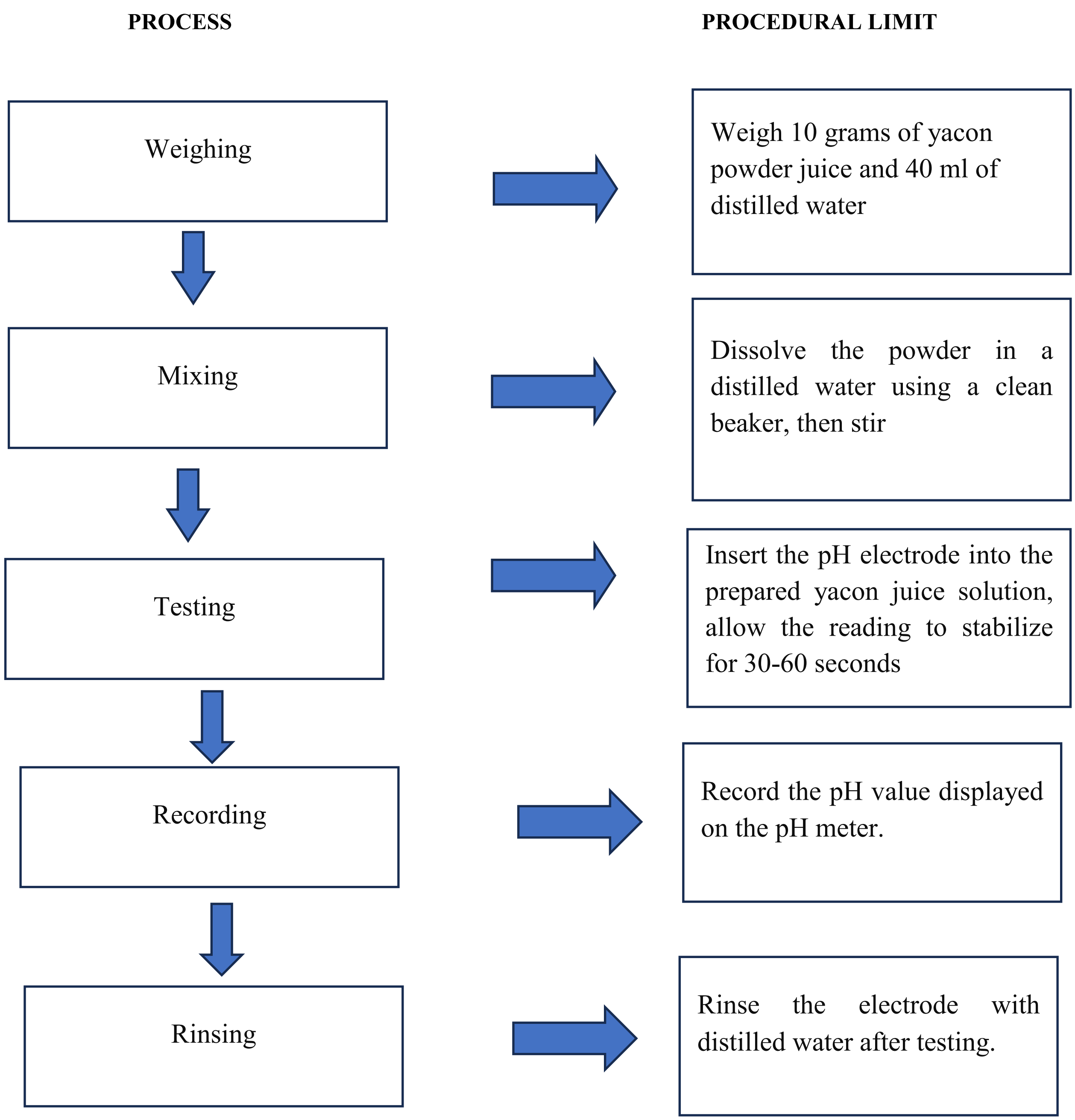


Data Analysis	Compare spectra from samples dried at different conditions to assess structural preservation.

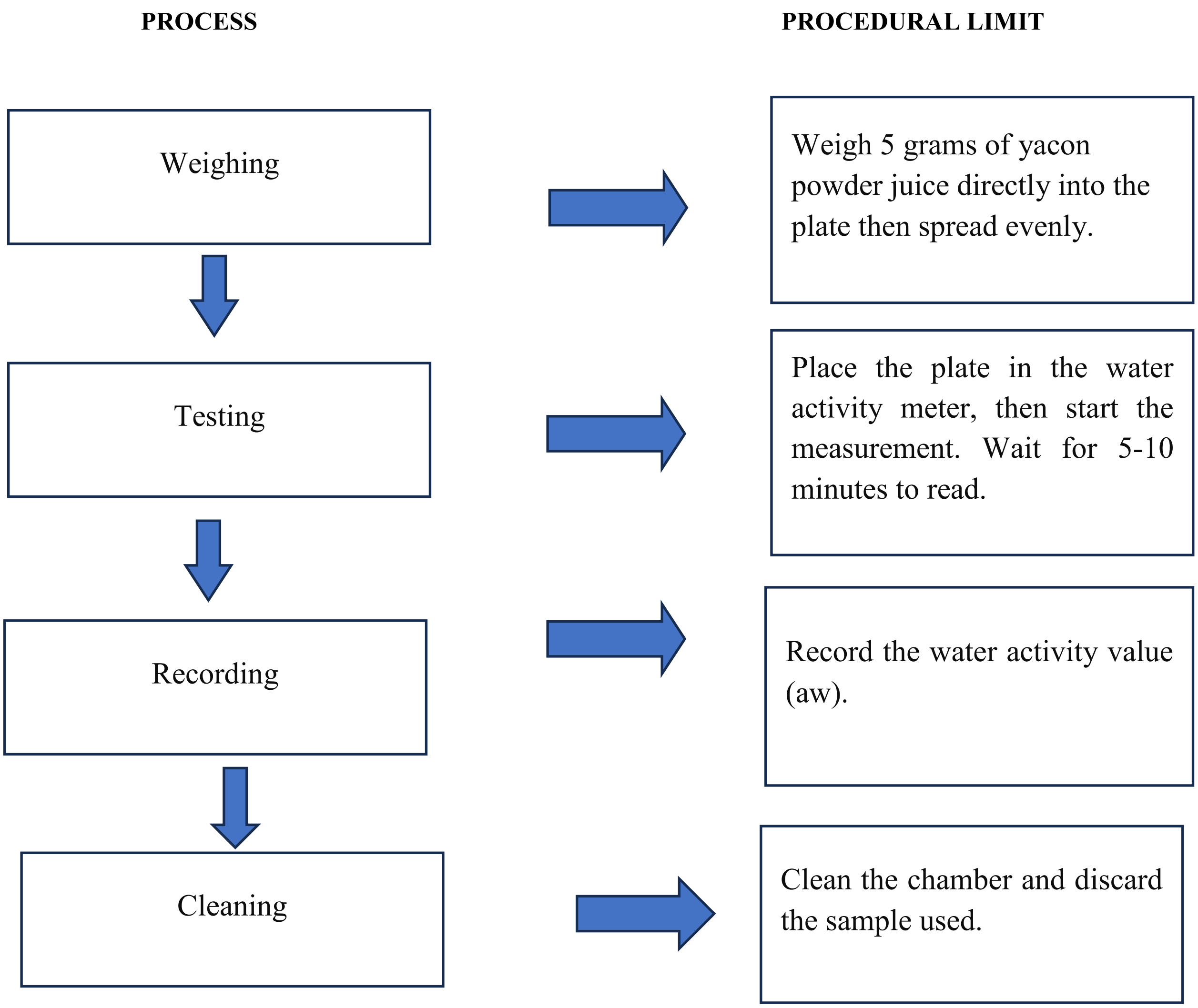
EXPERIMENTAL PROCEDURE YACON POWDER JUICE

PROCESS	**PROCEDURAL LIMIT**
Mis-en-place	Prepare all the ingredients, materials and equipment needed.
Compounding	Pour all the ingredients in sealed plastic bag, mix until it creates a homogenous powder mixture.
Filling	In a polyethylene or a laminated foil pouches within the acceptable range/50ml of water.
Sealing	Sealed the pouches for 1-2 seconds into a 150-180^{0}C.

EXPERIMENTAL PROCEDURE pH level of the Yacon Powder Juice



EXPERIMENTAL PROCEDURE water activity of the Yacon Powder Juice



EXPERIMENTAL PROCEDURE moisture content of the Yacon Powder Juice

PROCESS	**PROCEDURAL LIMIT**
Weighing	Weigh 5 grams of yacon powder juice into a clean and dry cruible.
Recording	Record the initial weight of the sample and the crucible.
Testing	Place the crucible with the sample in a preheated drying oven at 105^{0}C. Dry the sample for 10-20 mins or until constant weight is achieved.
Recording	Record the weight of the dried crudible.

EXPERIMENTAL PROCEDURE YACON POWDER JUICE

PROCESS	PROCEDURAL LIMIT
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
Data Analysis	Compare spectra from samples dried at different conditions to assess structural preservation. .

EXPERIMENTAL PROCEDURE YACON POWDER JUICE

PROCESS	PROCEDURAL LIMIT
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Population and Sampling
The raw yaconrootcrops used in this study were obtained from the municipality of Cervantes, Ilocos Sur.
The yacon roots were extracted and dried using an oven-dryer. Three (3) yacon powder samples were prepared for processing and analysis to evaluate consistency. Random sampling was employed to select yacon roots from different sources and harvests to ensure representativeness of the samples used in the study.

Data Gathering Instrument
The oven-drying process was conducted by precisely controlling the temperature and drying time according to the experimental matrix. Following drying, the physicochemical properties of the yacon powdersuch as moisture content, water activity, pH level, and particle sizewere assessed. Moisture content was determined via gravimetric analysis, water activity was measured using a water activity meter,and pH levels were recorded with a pH meter. To evaluate the structural integrity and functional groups of the carbohydrate components, Fourier Transform Infrared Spectroscopy (FTIR) was utilized.

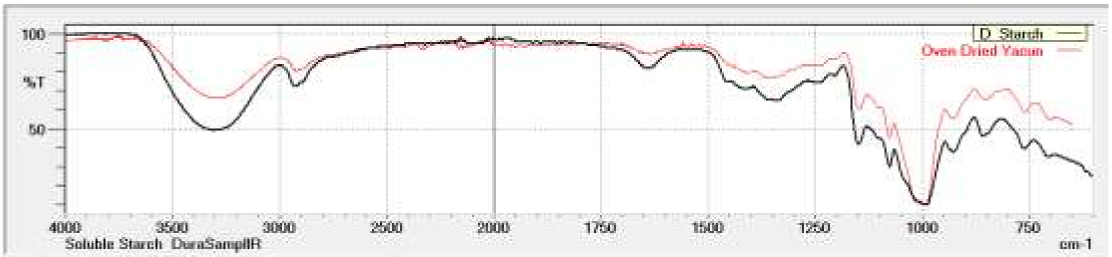
Statistical Treatment of Data
Statistical analyses, including Analysis of Variance (ANOVA), were performed to identify significant differences among treatments. Regression models were developed to describe the responses observed in the experiments. The optimization process for the drying conditions involved applying Response Surface Methodology (RSM) to determine the combination of temperature and drying time that maximized bioactivity and quality attributes of the yacon powder.

Results and Discussion :-

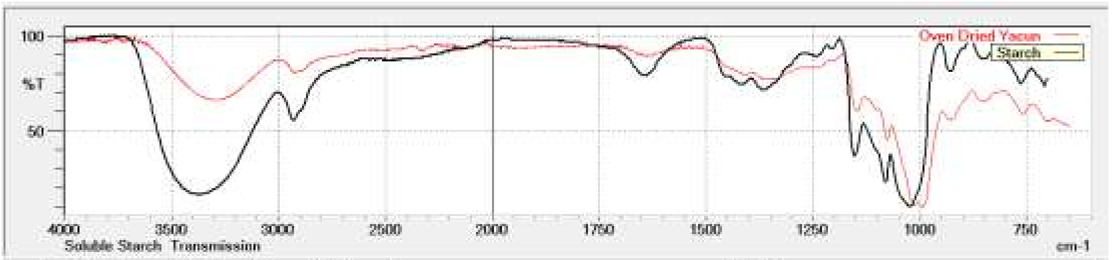
Fourier Transform Infrared Spectroscopy(FTIR)
FTIR spectroscopy of oven-dried yacon (Smallanthussonchifolius) powder showed clear absorption bands that are typical of polysaccharides, especially malto-oligosaccharides and soluble starch. Compounds like maltohexaose and maltoheptaose were found to have peaks that showed the presence of partially hydrolysed starch components. These spectral patterns support the sample's carbohydrate-rich nature, particularly in the areas of 1000–1200 cm^{-1} (C–O and C–C stretching) and 3300 cm^{-1} (O–H stretching).

Additionally, a high purity index of 0.9870 between samples that were oven-dried and those that were spray-dried indicates that drying results in little starch structural degradation, indicating that oven-drying is a successful preservation technique. These results suggest that yacon that has been oven-dried maintains a considerable amount of bioactive carbohydrates with proven prebiotic potential, which can support glycaemic control, intestinal health, and the creation of functional meals. These findings are consistent with recent research by Zhang et al. (2024), who emphasised FTIR as a dependable technique for identifying malto-oligosaccharides in processed starches, and Lachman et al. (2022), who noted the preservation of fructooligosaccharides in thermally treated yacon.

Additionally, recent findings in Food Chemistry (2023) support the conclusion that oven-drying maintains structural and functional integrity in yacon-derived carbohydrate matrices. Therefore, the spectral characterization supports the application of yacon powder in health-promoting food products, with oven-drying proving to be a suitable processing technique.



	Score	Library	Name	Comment
1	919	4 - ATR-Organic2	D_Starch	Soluble Starch DuraSamplIR
2	831	4 - T-Organic2	Starch	Soluble Starch Transmission
3	824	165 - IRs ATR Reagent2	165	Soluble Starch
4	822	2569 - Shimadzu Standar	MALTOHEXAOSE	MALTOHEXAOSE
5	818	2569 - Shimadzu Standar	MALTOHEPTAOSE	MALTOHEPTAOSE



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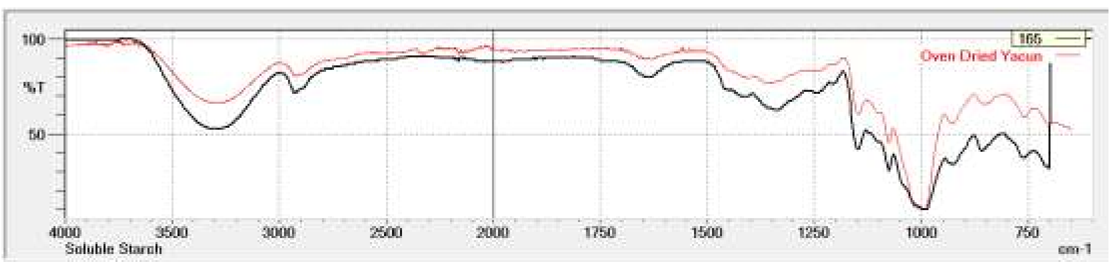

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Purity (similarity index)

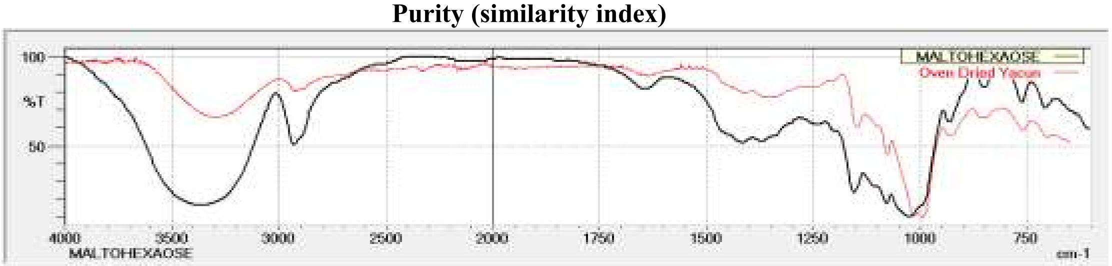

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Figure 1. Fourier Transform Infrared Spectroscopy (FTIR)

Physiochemical Laboratory Test

Table 1. Moisture content Analysis

Samples	Weight	Temp	Time(min)	% MC	SD
1	5.021	105	9.16	5.22	0.10
2	5.072	105	9.11	5.17	0.09
3	5.009	105	7.37	5.03	0.08

Table 1 indicates that the moisture content (% MC) of the samples of Yacon powder juice ranged from 5.03% to 5.22%, with an average of roughly 5.14%. The drying periods for all three samples varied from 7.37 to 9.16 minutes, and they were all examined at a consistent temperature of 105°C. In order to preserve the vitality of added probiotics and guarantee product quality during storage, the product's excellent shelf stability and decreased susceptibility to microbial growth are indicated by its comparatively low moisture content.

The moisture content of the Yacon powder juice samples was consistently low, ranging from 5.03% to 5.22%, with standard deviations of 0.08 to 0.10, indicating good reproducibility and precision in the drying process. Such low moisture levels are advantageous for enhancing the product's shelf stability and microbial safety, as moisture contents below 6% are widely regarded as optimal for inhibiting microbial growth and prolonging shelf life in dried fruit powders through the process of sealing and with a pH of 3.0 to 6.0 level. This aligns with the findings of Li et al. (2021), who emphasized that low moisture content in probiotic-enriched powders helps preserve both the functional compounds and the live microbial population.

Moisture content plays a pivotal role in determining the physicochemical stability of powdered functional foods. This is particularly pertinent for products aimed at preserving probiotic viability, since excess moisture can facilitate microbial proliferation and biochemical degradation, compromising both safety and functional properties of the product and the storage stability and probiotic viability across varying environmental conditions to optimize commercial applications. The minimal variation across samples reflects the effectiveness of the oven-drying process at 105°C, highlighting the process's control and reliability in achieving desired moisture levels.

These findings are corroborated by recent studies which emphasize that maintaining low moisture content is critical for preserving bioactive compounds, such as fructooligosaccharides and other prebiotic components in Yacon, thereby supporting its health benefits through proper storing and packaging and by maintaining the moisture content below 6% which may help improved stability, extended shelf-life and reduced biochemical degradation. According to Moreira et al. (2020), maintaining moisture content below 6% in powdered fruit products contributes to improved stability, extended shelf life, and reduced biochemical degradation. Moreover, low-moisture formulations are essential for preventing caking, facilitating better solubility, and enhancing sensory qualities, especially in reconstituted beverages (Silva et al., 2022). Low moisture levels assists in preventing caking, improving solubility, and maintaining the sensory quality of the reconstituted beverage.

Thus, results demonstrate that the drying conditions falls within the optimal range, and the drying process applied are suitable for producing a stable, nutritionally preserved without compromising the nutritional content and the prebiotic integrity of the root crops. Yacon powder that aligns with current industry standards and scientific literature advocating low-moisture content for functional, probiotic-enriched powders.

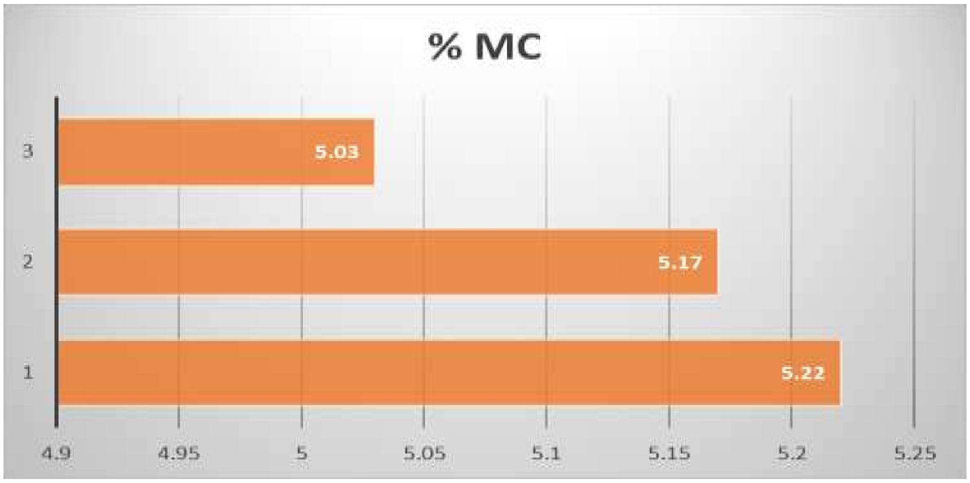

Figure 1. Percentage of Moisture Content of the Yacon Powder Jui

Table 2. Results of Water Activity of the Yacon Powder Juice

Time/Sample ID	aw (water activity)	T (Temperature)
12-10-48	0.503	25.2
12-21-36	0.483	26.0
12-32-16	0.477	26.1

The water activity (aw) test conducted on Yacon Powder Juice revealed values ranging from 0.477 to 0.503 across three samples, with corresponding measurement temperatures ranging from 22.0°C to 26.1°C. These Aw values fall well below the critical threshold of 0.6, which, according to food safety literature, is the level below which most bacteria, yeasts, and molds are unable to grow. This indicates that the product is microbiologically stable, and the risk of microbial spoilage is minimal under standard storage conditions.

The slight differences in aw values among the samples may be attributed to variations in moisture content, possible differences in drying or storage conditions, or minor inconsistencies in sample handling. Despite this, all values remained within a narrow range, and the temperatures during measurement were relatively stable, typical of controlled laboratory environments.

These findings are consistent with studies highlighting the shelf-stability benefits of low-aw food products, such as powdered juices and dehydrated fruits. As such, the Yacon Powder Juice demonstrates promising potential for extended shelf life, making it a viable product for commercial distribution, especially in settings where refrigeration may not be readily available. This low water activity also suggests suitability for further functional food product development if packaging and handling maintain these stability levels.

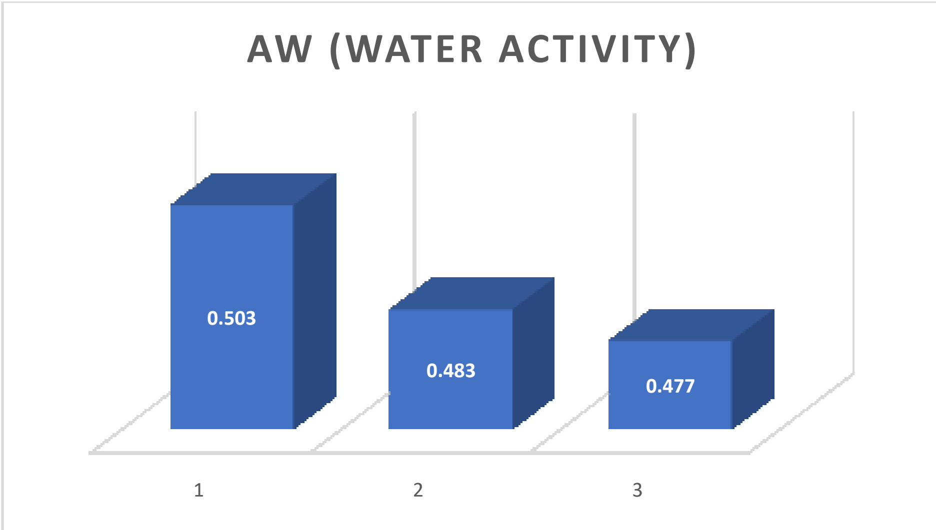

Figure 2. Water activity trend of Yacon Powder Juice

pH level of the Yacon Powder Juice

Table 3. Result of pH level of the Yacon Powder Juice

Sample	pH level	Temperature
10 grams	4.84	26.1^{0}C
10 grams	5.96	26.1^{0}C
10 grams	5.398	26.1^{0}C

Table 3 reveals the analysis of the pH levels of the yacon powder juice ranging from 4.84 to 5.96 at a constant temperature of 21.1^{0}C, which indicates that the juice powder exhibits a slightly acidic below 7.0 denotes acidity and this is supported on the study by Genta et al. (2005) yacon typically possesses a natural acidity due to its content of fructooligosacharides and phenolic compounds. The pH level falls within the typical range from fruit-based beverages which is usually have a pH ranging to 3.0 and 6.0, suggesting its suitability for safe consumption and its potential to inhibit the growth of pathogenic microorganisms. The slightly acidic environment may support the growth and stability of a probiotics, making it suitable base for functional beverage formulations. Slight acidity in beverages not only contributes to microbial stability but also enhances product shelf life when combined with proper storage and processing techniques (Zhu et al., 2022).

Moreover, the variation in pH across the three samples highlights the importance of standardizing the production processes to ensure consistency in taste, safety, and shelf-life. This pH result also aligns with findings from recent studies, such as those by Wu et al. (2023), which emphasized the stability of prebiotic and functional components in Yacon when processed into powder form and reconstituted into a beverage. The temperature at which the measurement was taken (26.1°C) is within standard room temperature, further validating the reliability of the reading under typical storage or consumption conditions.
This is supported on the study of Wu et al. (2023), highlighting the stability of Yacon's bioactive properties during powder processing and its ability to maintain functional integrity when rehydrated. The measurement at 26.1°C—near room temperature—adds to the relevance of the result, as it reflects common conditions under which the juice might be consumed or stored.

Thus, the result suggest that Yacon powder juice has potential as a base for developing health-promoting functional beverages, especially those aiming to support gut health through prebiotics and probiotics. Additionally, the mild acidity enhances palatability and may support flavor retention, making it appealing to consumers seeking nutritious, low-sugar alternatives. This also underscore the potential of Yacon Powder Juice as health-promoting product while emphasizing the need for quality control for its development.

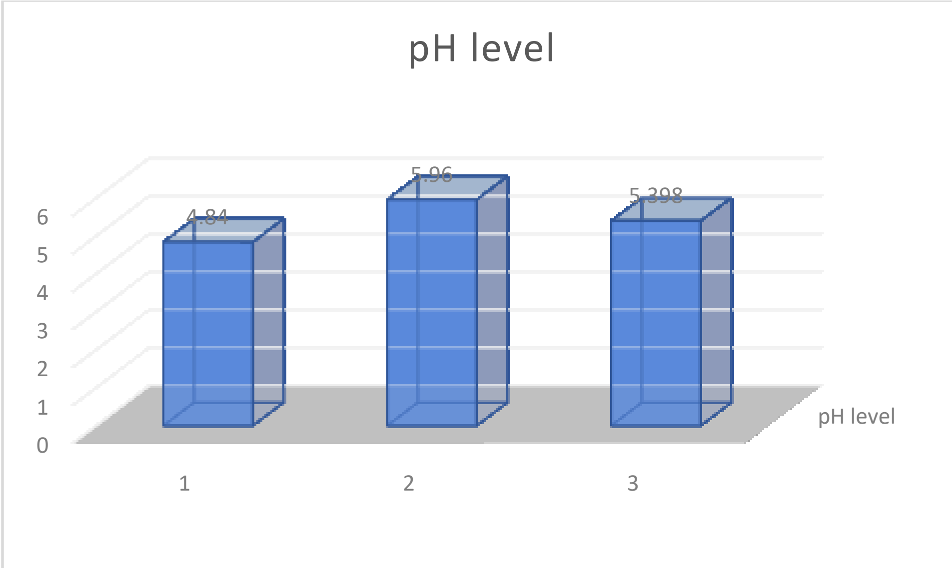

Figure 3. pH level of Yacon Powder Juice

Statistical Analysis

The statistical analysis of the experimental data, utilizing Analysis of Variance (ANOVA), revealed significant effects of drying temperature and time on the physicochemical and bioactive properties of the yacon powder. The regression models developed through Response Surface Methodology (RSM) effectively characterized the relationships between these factors and responses such as moisture content, water activity, pH, and fructooligosaccharide (FOS) retention.

The high coefficients of determination indicated a good fit for the models, confirming the relevance of the selected variables in influencing powder quality. Optimization results identified the ideal drying conditions at approximately 60°C for 8 to 10 hours, which maximized the preservation of bioactive compounds while ensuring desirable physicochemical attributes. Under these conditions, the yacon powder maintained a moisture content below 6%, water activity within safe storage limits, and high levels of FOS, demonstrating the efficacy of the optimized oven-drying process in producing a high-quality, functional ingredient with retained nutritional and prebiotic properties.

Conclusion:-

The study successfully optimized oven-drying conditions to produce high-quality yacon powder that retains significant levels of bioactive compounds, particularly fructooligosaccharides (FOS). Drying at approximately 60°C for 8 to 10 hours was found to be optimal, balancing energy efficiency, structural integrity, and preservation of nutritional and functional properties. The resulting powder demonstrated desirable physicochemical attributes—including low moisture content (<6%), low water activity, good structural integrity as confirmed by FTIR spectroscopy, and maintained bioactive compounds—making it suitable for use as a functional food ingredient with health benefits such as prebiotic effects and antioxidant activity.

APPEDICES

Preparation of the Yacon Powder Juice for Lab Testing

Preparing 10 grams of yacon powder juice for physicochemical testing

Physicochemical Testing of the Yacon Powder Juic

Checking the presence of Pathogenic Bacteria to the yacon powder juice

Checking the pH level of the Yacon Powder Juice

Checking the moisture content of the yacon powder juic

Checking the water activity of the yacon powder juice

Recommendations:-

1. Future studies could explore the sensory attributes and consumer acceptability of the developed yacon powder for commercial applications.
2. Additional research is suggested to assess the shelf life and stability of the powder under various storage conditions.
3. Incorporating the optimized drying process with probiotics to maximize its health benefits.

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