**CHAPTER ONE**

**INTRODUCTION**

**1.1 Background of the Study**

The blending of fruits with natural plant-based ingredients has become an innovative method of enhancing the nutritional, sensory, and health benefits of beverages. In recent years, the interest in healthy, natural, and functional drinks has significantly increased due to growing health consciousness among consumers. Citrus fruits such as lime, lemon, and orange are recognized globally for their refreshing taste, high vitamin C content, and antioxidant properties. When these fruits are blended with enriching agents such as soya bean milk and date palm extract, the resulting beverage not only delivers improved nutritional value but also introduces a unique flavor and texture profile (Adepoju *et al.,* 2020).

Citrus fruits are widely cultivated and consumed for their juicy pulp, rich in vitamins (particularly vitamin C), minerals, and phytochemicals such as flavonoids and polyphenols, which play crucial roles in boosting immunity, detoxifying the body, and promoting general well-being. Lime (*Citrus aurantiifolia*) and lemon (*Citrus limon*) are especially valued for their citric acid content, contributing to their tartness and natural preservative qualities. Orange (*Citrus sinensis*) is appreciated for its sweet, tangy flavor and abundant vitamin content, making it a staple in fruit juice production worldwide (Ohwesiri *et al.,* 2016).

Soya beans (*Glycine max*) milk, a plant-based dairy alternative, is derived from soaked and blended soya beans. It is a rich source of high-quality proteins, unsaturated fats, essential amino acids, isoflavones, and B vitamins. Soya milk has been noted for its cholesterol-lowering effects and benefits for lactose-intolerant individuals, making it an ideal fortifying agent for beverages (Akintayo *et al.,* 2019). Date palm (*Phoenix dactylifera*), commonly known as date fruit, is a natural sweetener packed with essential nutrients such as iron, potassium, calcium, fiber, and various antioxidants. The inclusion of date extract in fruit juice formulations enhances sweetness naturally while contributing significantly to the nutritional profile of the beverage (Rashid *et al.,* 2018).

Date palm (*Phoenix dactylifera*) is a fruit commonly consumed in many parts of the world for its natural sweetness and nutritional richness. Dates are rich in carbohydrates, dietary fiber, iron, potassium, and magnesium. They also provide natural sugars such as glucose and fructose, which can serve as a healthier alternative to refined sugars in juice formulations. Their inclusion in fruit juice not only enhances the taste profile with natural sweetness but also adds nutritional value, making the beverage a good source of energy and micronutrients. Blending citrus fruits with soy milk and date palm presents a unique innovation in the functional beverage industry. This fusion harness the tanginess of citrus, the creaminess of soy milk, and the natural sweetness of dates to produce a nutritionally balanced and refreshing drink. It also caters to consumers looking for plant-based, low-fat, lactose-free, and nutrient-rich alternatives. The inclusion of multiple functional ingredients makes this blend a potential health-promoting beverage, ideal for all age groups (Ohwesiri *et al.,* 2016).

There is a growing demand for healthier beverages that align with wellness trends and consumer awareness of the relationship between diet and health. Consumers are increasingly shifting away from synthetic and sugar-laden soft drinks toward naturally blended, functional beverages. As such, the production and evaluation of citrus-based juice blends enriched with soy milk and date palm not only address consumer needs but also provide a platform for further research and commercial development of innovative nutritional beverages.

**1.2 Statement of the Problem**

The demand for functional, natural, and nutritious beverages is on the rise as consumers seek healthier alternatives to carbonated and sugary drinks. While citrus fruit juices are widely appreciated for their refreshing taste and health benefits, there is limited research on the enhancement of such juices using plant-based milk and natural sweeteners like date palm extract.

Citrus juices on their own may sometimes be too acidic or sour for certain consumers, potentially affecting their palatability. Soya milk, though nutritious, may have a characteristic bean-like flavor that may not appeal to everyone. Similarly, date palm fruit, despite its richness in natural sugars and minerals, is underutilized in mainstream beverage production.

There is a need to explore the potential of blending these ingredients to create a more appealing, health-promoting, and nutritionally superior beverage. However, the lack of data on the nutritional composition, sensory evaluation, and consumer acceptability of such a blend poses a challenge for its development and potential commercialization.

This study, therefore, aims to produce and evaluate a juice blend using three citrus fruits (lime, lemon, and orange), enriched with soya beans milk and date palm, and to analyze its nutritional and sensory attributes.

**1.3 Aim and Objectives of the Study**

The main aim of this study is to produce and evaluate a juice blend using lime, lemon, and orange enriched with soya bean milk and date palm. The specific objectives are to:

1. Produce juice blends from three citrus fruits (lime, lemon, orange) in different ratios enriched with soya bean milk and date palm extract.
2. Conduct sensory evaluation of the different juice blends.
3. Analyze the mineral composition (e.g., calcium, potassium, phosphorus, iron) of the juice.
4. Analyze the vitamin composition (e.g., vitamins A, B1, C, D) of the juice.

**1.4 Significance of the Study**

This study is significant in promoting the development of a nutritionally enhanced and consumer-acceptable functional beverage that combines the health benefits of citrus fruits, soya milk, and date palm. Each component brings unique nutritional advantages; Lime, lemon, and orange juices are excellent sources of vitamin C and antioxidants that support immune health, detoxification, and skin rejuvenation, Soya milk contributes plant-based protein, healthy fats, and isoflavones that are beneficial for heart health and hormonal balance, Date palm offers natural sweetness, dietary fiber, and vital minerals such as iron and potassium.

Blending these ingredients can result in a functional juice that is not only refreshing and tasty but also rich in vitamins, minerals, antioxidants, and plant-based protein. This product has the potential to meet the dietary needs of a broad range of consumers, including vegetarians, vegans, and lactose-intolerant individuals. The findings of this study may also provide a foundation for further research and commercial development in the functional beverage industry.

**1.5 Scope and Limitation of the Study**

This study is focused on the production and evaluation of juice blends prepared from lime, lemon, and orange, enriched with soya bean milk and date palm extract. The scope includes: Formulating juice blends in varying proportions to achieve optimal flavor and nutritional value, conducting sensory evaluation to assess taste, aroma, color, and overall acceptability and Analyzing the nutritional content of the juice blends with emphasis on vitamins (A, B1, C, D) and minerals (Calcium, Potassium, Phosphorus, Iron).

# CHAPTER TWO

# LITERATURE REVIEW

### ****2.1 Introduction****

Fruit juices are vital components of human diets due to their nutritional, therapeutic, and refreshing properties. Citrus fruits like lime (Citrus aurantifolia), lemon (Citrus limon), and orange (Citrus sinensis) are rich sources of vitamin C, flavonoids, and essential antioxidants. The blending of citrus juice with plant-based milk such as soya milk and natural sweeteners like date palm enhances the nutritional and functional attributes of the juice (Albuquerque et al., 2021). This chapter presents a review of relevant literature on citrus fruits, soya milk, date palm, and their synergistic roles in enriched juice production.

### ****2.2 Citrus Fruits: Nutritional and Health Benefits****

Citrus fruits such as oranges (*Citrus sinensis*), lemons (*Citrus limon*), and limes (*Citrus aurantifolia*) are among the most popular and widely consumed fruits globally. They are cherished not only for their refreshing flavor but also for their dense nutritional composition and numerous health benefits. These fruits are particularly rich in ascorbic acid (vitamin C), which plays a vital role in boosting the immune system, promoting collagen synthesis, and enhancing iron absorption (Oliveira et al., 2023). In addition to vitamin C, citrus fruits contain significant amounts of citric acid, which contributes to their tangy flavor and also aids in digestion and the prevention of kidney stones.

Citrus fruits are also notable for their phytochemical content, including flavonoids, carotenoids, and phenolic compounds. These bioactive constituents exhibit strong antioxidant, anti-inflammatory, and antimicrobial activities, making citrus fruits beneficial for the prevention and management of chronic diseases such as cardiovascular disorders, certain cancers, and neurodegenerative diseases (Ibrahim et al., 2022). For instance, flavonoids like hesperidin and naringin, found abundantly in oranges and lemons, have been linked to reduced oxidative stress and improved blood lipid profiles (Adeola & Bello, 2022).

Orange juice, in particular, is well-known for its sweet taste and high concentration of vitamin C. It also provides essential nutrients such as potassium, which supports heart health; folate, which is crucial for DNA synthesis and fetal development; and thiamin (vitamin B1), which aids in energy metabolism (Mohammed et al., 2021). On the other hand, lemon and lime juices, though more acidic and sour in taste, are potent detoxifiers. They help maintain the body’s pH balance and support liver function due to their alkalizing effects after digestion (Azeez et al., 2023).

The combination of orange, lemon, and lime juices in a single beverage blend offers a balanced profile in terms of flavor, acidity, and nutritional content. While the sweetness of orange offsets the sharpness of lemon and lime, the synergistic blend provides a wider spectrum of vitamins, antioxidants, and phytochemicals. This makes multi-citrus juice blends not only more palatable but also more effective as a functional beverage for promoting overall health and well-being.

### ****2.3 Soya Beans Milk as a Nutrient Enricher****

Soya beans milk is a widely accepted plant-based milk alternative derived from soaked and finely ground soybeans. It is highly valued for its nutritional richness, particularly its high protein content and the presence of essential amino acids that are comparable to those found in animal proteins (Adebayo et al., 2022). Soya milk is also rich in bioactive compounds such as isoflavones, which have been scientifically linked to the reduction of LDL cholesterol levels, improved cardiovascular health, and decreased risk of hormone-related cancers (Ojo & Udeh, 2021). This makes it an ideal supplement for health-conscious consumers, vegetarians, and individuals who are lactose intolerant.

Integrating soya milk into fruit juice formulations not only boosts the protein content but also enhances the functional and nutritional profile of the beverage. Most fruit juices are naturally low in protein, limiting their role in supporting muscle growth and cellular repair. By blending soya milk with fruit juice, the resulting product becomes a more balanced source of both macronutrients and micronutrients (Chinonso et al., 2023). This synergy addresses nutritional gaps in standard fruit juices and meets the growing demand for functional beverages with added health benefits.

In addition to nutritional enrichment, soya milk significantly enhances the physical characteristics of juice blends. It introduces a creamy and smooth mouthfeel, improving the texture and overall sensory appeal of the final product. This is particularly useful in masking the sharp acidity of citrus fruits like lime and lemon, resulting in a more palatable and balanced beverage (Ezeokoli et al., 2022). Moreover, the emulsifying properties of soy proteins help to stabilize the juice blend, minimizing phase separation and improving the shelf-life of the product.

Soya milk also provides a good source of vitamins such as vitamin B12 (especially when fortified), folate, and minerals including calcium, magnesium, and potassium. These nutrients play essential roles in bone development, muscle contraction, and nerve function (Ibrahim & Bello, 2024). When consumed regularly, beverages enriched with soya milk can support bone health, metabolic function, and hormonal balance. For populations in developing regions with limited access to dairy products, soya milk-enriched juices offer a cost-effective alternative for obtaining high-quality plant-based nutrition.

Additionally, studies have shown that soya milk possesses antioxidant and anti-inflammatory properties due to its isoflavone and polyphenol content. These compounds help in combating oxidative stress, which is linked to the development of chronic diseases such as diabetes, cancer, and cardiovascular ailments (Adepoju et al., 2021). Therefore, the inclusion of soya milk in citrus fruit juices is not only a method of nutritional fortification but also a strategic approach to producing health-promoting functional beverages suitable for all age groups.

### ****2.4 Date Palm as a Natural Sweetener****

Date palm (*Phoenix dactylifera*) is a highly nutritious fruit known for its rich concentration of natural sugars such as glucose, fructose, and sucrose. It serves as an excellent natural sweetening agent, especially in beverage production, where it enhances the taste without the health risks associated with refined sugar. In addition to sugars, dates are abundant in essential nutrients including dietary fiber, potassium, magnesium, calcium, and B-complex vitamins, making them a functional ingredient for promoting overall health and wellness (Hassan et al., 2021).

The use of date palm in juice formulations not only improves the palatability of sour fruits like lime and lemon but also contributes to a balanced flavor profile. Its naturally sweet and slightly caramel-like taste masks the tartness of citrus juices, resulting in a more acceptable and flavorful beverage for consumers of all ages (Adeleke & Musa, 2022). This makes date palm an excellent alternative to artificial sweeteners or refined sugar, which have been associated with obesity, insulin resistance, and other metabolic disorders.

From a health perspective, dates provide more than just sweetness. Their high antioxidant content, particularly phenolic compounds and flavonoids, plays a significant role in combating oxidative stress and inflammation in the body. These antioxidants help protect cells from damage, lower the risk of chronic diseases, and support the immune system (Al-Farsi et al., 2021). Therefore, enriching citrus fruit juices with date palm not only enhances taste but also significantly boosts the nutritional and therapeutic value of the final product.

Furthermore, the high energy yield of dates due to their natural sugars makes them ideal for inclusion in beverages consumed by children, athletes, and individuals requiring quick energy boosts. According to Ezeonu et al. (2023), beverages containing date palm extracts have been shown to improve post-exercise recovery and maintain blood glucose levels during physical activities. This makes such juice blends particularly valuable in sports nutrition and recovery drinks.

Additionally, date palm’s rich fiber content contributes to improved digestion and gut health. Dietary fiber aids in bowel regulation, promotes satiety, and supports the growth of beneficial gut microbiota (Umar & Sadiq, 2024). When incorporated into fruit juices, especially those lacking in fiber, date palm helps in creating a more complete and health-enhancing beverage. Its synergistic interaction with citrus fruits and soy milk results in a product that is not only appealing and naturally sweetened but also supportive of cardiovascular, digestive, and metabolic health.

**2.5 Related Studies**

Onyekwelu (2016) conducted a study on the physicochemical properties and sensory evaluation of mixed fruit juice comprising orange, watermelon, and tangerine, sweetened with date syrup. The inclusion of date syrup enhanced the juice's pH, total soluble solids, vitamin C, and calcium content. Sensory analysis indicated improved flavor, taste, and overall acceptability, highlighting date syrup's potential as a natural sweetener in fruit beverages.

Shanta *et al.* (2021) developed ready-to-serve (RTS) drinks from date palm juice (Phoenix sylvestris). By concentrating the juice and treating it with potassium metabisulfite, they achieved extended shelf life and maintained quality. Sensory evaluations favored the RTS drink containing 30% date palm juice, demonstrating its viability as a natural sweetener and functional ingredient in beverages.

Ogblechi and Ige (2019) formulated a predictive model for juice extraction from date palm fruits. By optimizing factors like steaming time and diffusion coefficients, they enhanced juice yield. This model aids in efficient juice extraction processes, crucial for integrating date palm juice into commercial beverage production.

Arum and Ani (2021) explored the production and quality evaluation of mixed juice blends from soursop, mango, and watermelon. Their findings emphasized the importance of selecting appropriate fruit combinations to achieve desirable sensory attributes, which is pertinent when considering the addition of soya milk and date palm to citrus-based juices.

Ahmed (2016) assessed the impact of date syrup on mixed fruit juices. The results showed that date syrup not only improved the nutritional profile by increasing vitamin C and calcium levels but also enhanced the sensory qualities, making the juice more appealing to consumers.

Heliyon (2021) focused on developing value-added drinks from date palm juice. The study highlighted the successful formulation of RTS beverages with varying concentrations of date palm juice, noting that a 30% concentration yielded the best sensory acceptance, reinforcing the fruit's utility in beverage enhancement.

James (2021) investigated the production and quality evaluation of mixed juice blends from soursop, mango, and watermelon. The research underscored the significance of fruit selection and blending ratios in achieving optimal nutritional and sensory properties, which is relevant when incorporating soya milk and date palm into citrus juices.

*Heliyon* (2021) published a study on the development of value-added drinks from date palm juice, emphasizing the importance of preservation techniques and optimal juice concentrations to maintain quality and extend shelf life, which is crucial for commercial beverage production.

# CHAPTER THREE

# MATERIAL AND METHOD

## 3.1 Study Area

The study was conducted in the department of nutrition and dietetics, food science and technology laboratory, federal polytechnic Mubi, Adamawa state.

## 3.2 Sample Collection

Orange and pineapple were obtained from Mubi main market, while beetroot was obtained from Yola modern market.

## 3.3 Materials

1. Electrical blender
2. Bowl
3. Knife
4. Glass cup
5. Tray
6. Chopping board
7. Plastic bottle

## 3.4 Preparation of pineapple/beetroot/orange juice blends.

The oranges were washed, peeled, sliced, and set aside, while the pineapples were also washed, peeled, sliced, and set aside. The beetroots were similarly washed, peeled, and set aside. These ingredients were then organized into different sample ratios, labeled as Sample A, Sample B, and Sample C, as detailed in Table 3.1.

**Table 3.1: Sample ratio**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sample** | **Pineapple** | **Orange** | **Beetroot** |
| A | 60% | 15% | 25% |
| B | 25% | 60% | 15% |
| C | 15% | 25% | 60% |

The three sample were packed in a clean container and were taken for analysis, some portion of the samples were given to the panelist for sensory evaluation.

**Orange**

**Beetroot**

**Pineapple**

Sorting

Washing

Sorting

Peeling

Cutting

Washing

Washing

Blending

Peeling

Cutting

Juice extraction

Cutting

Blending

Sieving

Blending

Sieving

Packaging

Sieving

Peeling

Packaging

Packaging

Figure 3.1: Flowchart of Juice from orange, beetroot, pineapple blends

## 3.5 Mineral Determination

The mineral content of the juice samples were determined using the methods of the (AOAC, 2000)

## 3.6 TTS (brix %) measurement

The prepared drinks were analyzed for total soluble solids (TSS) by Refractometer (Abbe Refractometer Model 2WAJ). A few drops of well homogenized sample were taken on prism of Refractometer and direct reading was taken by reading the scale in meter as described in (AOAC, 2000).

## 3.7 pH Determination

The pH of each sample was determined with digital pH meter. A sufficient quantity (50mL) of fruit drink was taken in 100mL beaker and pH meter was used to record pH according to method explained in (AOAC, 2005).

## 3.8 Vitamin Content Determination

The vitamin content of the juice samples were determined using the methods of the (AOAC, 2000)

## 3.9 Sensory Evaluation

The sensory characteristics with respect to color, taste, flavor, mouth-feel and overall acceptability of each sample was evaluated by 20 semi-trained panelists using the method described by (Larmonde, 1977). The panelists were asked to record their observations on the sensory sheet based on a 9-point hedonic scale (where 9 and 1 points showing like extremely and dislike extremely).