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# Formulation and Evaluation of Natural Fruit and Seed Based Multivitamin–Multimineral Nutritional Powder

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**Abstract:** *The present study was aimed at the formulation and evaluation of a natural fruit and seed based multivitamin–multimineral nutritional powder using nutrient-rich plant ingredients. The formulation was prepared using dried fruit powders such as amla, banana, pomegranate, and beetroot along with seed powders including pumpkin, flaxseed, sunflower, and chia seeds. The ingredients were selected based on their rich content of vitamins, minerals, antioxidants, dietary fibers, and essential fatty acids. Different formulations were prepared in varying proportions and optimized on the basis of nutritional composition and sensory evaluation. The prepared nutritional powder was evaluated for physicochemical parameters including color, odor, taste, bulk density, moisture content, ash value, pH, and solubility. Nutritional analysis such as protein, carbohydrate, fat, fiber, calcium, iron, zinc, and vitamin C content was also carried out. Sensory evaluation was performed using a 9-point hedonic scale to determine overall acceptability. The optimized formulation showed good nutritional value, acceptable sensory characteristics, and satisfactory stability during storage. The study concluded that the developed nutritional powder can serve as a natural health supplement and may help in overcoming vitamin and mineral deficiencies in daily diet.*

**Keywords** Natural nutritional powder, Multivitamin, Multimineral, Fruit powder, Seed powder, Nutraceutical, Sensory evaluation.

## I. INTRODUCTION

**Oral Route of Administration :**

The oral route is the administration of drugs by mouth, where the formulation is swallowed and the drug is absorbed primarily through the gastrointestinal (GI) tract. It is the most common, convenient, and cost-effective route for systemic drug delivery.

**Why the Oral Route Is Preferable ?**

The oral route remains the most widely preferred method of drug administration across the world, and this preference is rooted in a combination of patient-centered, practical, and economic factors. From a patient perspective, oral administration is non-invasive, painless, and does not require specialized equipment or trained healthcare personnel, allowing for convenient self-medication at home. This ease of use directly translates into higher patient compliance and adherence, because swallowing a tablet or capsule is far more acceptable to most people than receiving injections or undergoing procedures.


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**Powder formulation**

In the realm of pharmaceutical and nutraceutical science, the powder dosage form represents one of the oldest yet most technically refined methods of oral delivery. Defined as a mixture of finely divided solids, powders serve as the foundational precursor to tablets and capsules, but they offer distinct therapeutic advantages when administered in their raw, granular state. When utilized for multivitamins, this dosage form prioritizes biochemical availability and consumer accessibility over the convenience of a compressed pill.

Powder formulation is a solid dosage form where active ingredients are blended with other powdered materials for direct use. It's made by mixing the active component, which provides the intended effect, with excipients that handle functions like stability, flow, and taste. These formulations are used across pharma, supplements, food, and cosmetics, and "direct administration" usually means you take the powder as-is or stir it into liquid before consuming.

While capsules and tablets have long dominated the pharmaceutical market, the powder dosage form remains one of the most fundamental and versatile methods of oral administration. In modern nutraceuticals and medicine, powders are not merely "crushed pills" but are sophisticated mixtures of finely divided solids, engineered for specific flow properties, stability, and therapeutic release.

**Nutraceutical**

The term nutraceutical was coined in 1989 by Dr. Stephen DeFelice, combining nutrition + pharmaceutical.

Definition: A nutraceutical is a food, food component, or dietary supplement that provides medical or health benefits, including the prevention and/or treatment of disease, beyond basic nutritional value.They occupy the space between food and drugs – not strictly food, not strictly medicine, but taken for health promotion.

**Why nutraceuticals ?**

In today's fast-paced lifestyle, daily use of nutraceuticals has become increasingly relevant because modern diets and living conditions often leave nutritional gaps that regular food alone may not fill. Processed foods, depleted soil quality, long working hours, stress, pollution, and irregular eating patterns mean that many people do not consistently get adequate amounts of essential vitamins, minerals, antioxidants, fiber, or beneficial fatty acids from meals alone. Nutraceuticals help bridge these gaps by supplying concentrated, bioactive nutrients that support overall wellness, rather than treating a specific disease after it appears.

Powder formulations are one of the most common ways to deliver nutraceuticals, and they're often preferred over tablets, capsules, or liquids for several practical, pharmacotechnical, and patient-related reasons.

Nutraceutical powders should be administered when you need fast dissolution, dose flexibility, high daily intake, better stability, and fewer excipients. They're especially valuable for proteins, fibers, probiotics, electrolytes, and multi-ingredient wellness blends. For compliance-critical, taste-sensitive, or travel use, unit-dose sachets combine the benefits of powders with convenience.

**Minerals**

In the context of human biology and nutrition, minerals are inorganic elements that originate in the earth and cannot be made by living organisms. Unlike vitamins, which are organic substances (made by plants or animals), minerals maintain their chemical structure regardless of whether they are heated, frozen, or exposed to air.

Plants get minerals from the soil or water, and humans obtain them by consuming those plants—or the animals that have eaten them.

**Classification of Minerals**

**1. Macrominerals (Major Minerals)**

The body needs these in relatively large amounts (typically more than 100 mg per day) to perform vital functions such as maintaining fluid balance and bone health.

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Calcium: Essential for bone structure, blood clotting, and nerve signaling. Magnesium: Involved in over 300 biochemical reactions, including muscle function and energy production.
Phosphorus: A key component of DNA, RNA, and cell membranes. Electrolytes (Sodium, Potassium, Chloride): These manage the body's water balance and electrical gradients across cell membranes.

**2. Trace Minerals (Microminerals)**
These are needed in much smaller quantities (often less than 20 mg per day), but they are no less important for health.
Iron: Vital for the formation of hemoglobin, which carries oxygen in the blood.
Zinc: Supports immune function, wound healing, and DNA synthesis. Iodine: Necessary for the production of thyroid hormones that regulate metabolism.
Copper, Selenium, and Manganese: Often act as cofactors for antioxidant enzymes.

**Antioxidants**
Antioxidants are substances that inhibit oxidation, especially those used to counteract the deterioration caused by oxidative processes.In a biochemical context, an antioxidant is a molecule that is capable of preventing or slowing the oxidation of other molecules by neutralizing free radicals. Free radicals are atoms or molecules with unpaired electrons that are highly reactive and can initiate chain reactions, leading to cellular damage. Antioxidants function by donating an electron to a free radical, thereby stabilizing it and terminating the oxidative chain reaction without becoming destabilized themselves.
Antioxidants are like little protectors inside your body. Every day, your body makes unstable bits called free radicals from things like breathing, food, sunlight, and pollution. Free radicals are harmful because they try to steal from your healthy cells, and that stealing causes damage. This damage is called oxidation, and it's the same thing that makes a cut apple turn brown. Antioxidants stop that damage by giving free radicals what they want, so the free radicals don't have to attack your cells. Your body makes some antioxidants on its own, and you also get them from food. Fruits and vegetables with lots of color, like blueberries, oranges, spinach, and carrots, are packed with them. Basically, antioxidants help keep your cells safe from getting worn out too fast.

**What Food Antioxidants Are ?**
Food antioxidants are substances present in or added to foods that prevent, delay, or reduce oxidative damage. Oxidation in food causes rancidity of fats, browning of fruits, loss of vitamins, and off-flavors. In the human body, these same compounds can neutralize free radicals and reactive oxygen species (ROS) which are linked to cellular aging and chronic disease.

**Why Food Antioxidants Matter ?**
For food quality: Prevent rancid smell in oils, color loss in spices, and nutrient degradation. Rosemary extract is now used as a "natural BHT" in many products.
For health: Diets high in fruits, vegetables, and spices are associated with lower risk of heart disease, certain cancers, and cognitive decline. The link is attributed partly to antioxidants, though clinical trials with high-dose single antioxidants have shown mixed results. This is called the "antioxidant paradox" — whole foods work better than isolated pills.

**Vitamins**
Vitamins are organic compounds which are essential for normal growth and nutrition and are required in small quantities in the diet because they cannot be synthesised by the body. The importance of vitamins as drugs is primarily in the prevention and treatment of deficiency diseases. As these vitamins are not synthesised naturally in the human body a balanced diet is mandatory to keep the amount of vitamins at the required level. However, at times dietary

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habits can create a deficiency of these vitamins. For these conditions, multivitamins tablets are available in the market for the adequate supply of vitamins. Vitamin deficiencies occur due to inadequate intake, malabsorption, increased tissue needs, increased excretion, certain genetic abnormalities and drug-vitamin interaction .
Vitamins are groups of complex organic compounds found in foodstuffs and essential for a healthy metabolism. Their deficiency can cause disorders, whereas resupply of these nutrients can alleviate deficiency symptoms. Vitamins are different from other food nutrients due to their distinct organic nature, and their classification depends on their chemical nature and function. Growth, development, health, and reproduction require minute amounts of vitamins. Some vitamins synthesised from other sources in the body deviate from the usual definition of Vitamins. For instance, Animals integrateascorbic acid, tryptophan an essential amino acid produce niacin, while UV radiation from sunlight synthesises vitamin D.

Generally, classification of Vitamins is into two groups:
1) Water-soluble vitamins
2) Fat-soluble vitamins

**Vitamins functions and deficiencies:**

| Vitamin | VitaminType | Functions | Deficiency |
|---|---|---|---|
| Vit A | Fat Soluble | Vision, Reproductionand Immunity | Night-blindness |
| Vit B | Water Soluble | Growth, development and cellular agility | Beri-beri |
| Vit C | Water Soluble | For bone health andstability | Scurvy |
| Vit D | Fat Soluble | maintaining strengthand integrity of your bones | Rickets in children and osteomalacia in Adults |
| Vit E | Fat soluble | Antioxidant, | Cell Membrane damage especially red blood cells |
| Vit K | Fat Soluble | Formation of clottingfactors in the blood | Haemorrhage |

**Ingredient profile:**
1. Banana Powder
• Synonyms : Kela, Plantain ,Kela , Keli
• Biological Source : The fresh ripe fruit of Musa paradisiaca L. or Musa sapientum L.
• Family: Musaceae
• Nutrition : Energy , Carbohydrates ,Dietary Fiber , Protein , Fat
• Vitamins: Vitamin C,Vitamin B6, Folate (B9), Riboflavin (B2)

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• Minerals : Potassium, Magnesium,Phosphorus ,Calcium, Iron.
• Antioxidants & Phytochemicals
1. Polyphenols : dopamine, catechin, gallocatechin
2. Carotenoids :beta-carotene, alpha-carotene
3. Leucocyanidin : Present in unripe fruit, anti-ulcer activity
• Uses :
1. Nutritional: Instant energy source. High potassium supports electrolyte balance and muscle function.
2. Pharmaceutical : Banana powder used as demulcent and adsorbent in antidiarrheal formulations.
3. Therapeutic : Traditionally used for gastric ulcers due to leucocyanidin. Unripe banana pectin helps manage diarrhea.

**2. Apple Powder**

• Synonyms: Seb, Safarchand, Seva
• Biological Source : The fresh ripe fruit of Malus domestica Borkh. Also known as Malus pumila .
• Family : Rosaceae
• Nutrition : Energy ,Water ,Carbohydrates , Dietary Fiber
Sugars ,Protein ,Fat ,Pectin
• Vitamins :Vitamin C, Vitamin K, Vitamin E , Vitamin B6
• Minerals : Potassium, Calcium ,Magnesium ,Phosphorus
• Antioxidants & Phytochemicals :
1. Polyphenols : quercetin, catechin, chlorogenic acid,
2. Flavonoids : quercetin glycosides, epicatechin
• Uses :
1. Nutritional : Low-GI fruit for general health, weight management, dietary fiber source
2. Pharmaceutical : Source of pectin used as suspending agent, demulcent, and in antidiarrheal prepration.
3. Therapeutic : Traditionally for digestive issues, mild laxative, helps reduce LDL cholesterol
4. Food Industry: Jams, juices, cider, vinegar. Spray-dried powder as natural flavor/sweetener in supplements
5. Cosmetic : Extract used for antioxidant and mild astringent properties .

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**3. Pineapple Powder**

• Synonyms: Ananas, Anannas .
• Biological Source : The fresh ripe fruit of Ananas comosus (L.) Merr. Also known as Ananas sativus Schult.
• Family: Bromeliaceae
• Nutrition : Energy ,Water ,Carbohydrates ,Dietary Fiber , Protein , Fat .
• Vitamins: Vitamin C ,Vitamin B1 (Thiamine) ,Vitamin B6 , Folate (B9)
• Minerals : Manganese ,Potassium ,Copper, Magnesium ,Calcium
• Antioxidants & Phytochemicals :
1. Bromelain : proteolytic enzyme complex, anti-inflammatory
2. Polyphenols: gallic acid, catechin, epicatechin, ferulic acid
• Uses :
1. Nutritional : High vitamin C fruit for immunity. Bromelain aids protein digestion.
2. Pharmaceutical : Bromelain extracted for anti-inflammatory, anti-edema, and digestive enzyme tablets.
3. Therapeutic : Traditionally used for indigestion, sinusitis, and as anti-inflammatory. Bromelain may reduce swelling and bruising.

**4. Papaya Powder**

• Synonyms : Papita, Pawpaw , Papita , Papai
• Biological source : The fresh ripe fruit of Carica papaya L.
• Family : Caricaceae
• Nutrition : Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins : Vitamin C ,Vitamin A ,Folate (B9),Vitamin E ,Vitamin K
• Minerals : Potassium, Magnesium, Calcium, Phosphorus, Iron
• Antioxidants & Phytochemicals :
1. Papain : proteolytic enzyme, mainly in latex/unripe fruit
2. Carotenoids : beta-carotene, lycopene, beta-cryptoxanthin

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3. Polyphenols: ferulic acid, caffeic acid, rutin
4. Chymopapain : Protease with anti-inflammatory activity
• Uses :
1. Nutritional: Rich source of vitamin C and A. Low-calorie fruit for weight management and eye health.
2. Pharmaceutical : Papain extracted from latex for digestive enzyme tablets, anti-inflammatory drugs .
3. Therapeutic : Traditionally used for indigestion, constipation, and worm infestation .
4. Food Industry : Juices, nectars, jam, candy. Green papaya used in salads. Papain used for chill-proofing beer and clarifying beverages
5. Cosmetic : Fruit pulp and papain used in exfoliating scrubs, face packs, and skin-lightening products for enzymatic renewal .

**5. Orange Powder**


Orange Powder

• Synonyms : Santra, Narangi , Santre .
• Biological Source : The fresh ripe fruit of Citrus sinensis (L.)
- Also known as Sweet Orange.
• Family : Rutaceae
• Nutrition : Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins : Vitamin C, Folate (B9) ,Vitamin B1 ,Vitamin A ,Vitamin B6
• Minerals : Potassium ,Calcium ,Magnesium Phosphorus Copper
• Antioxidants & Phytochemicals:
1. Flavonoids : hesperidin, naringin, narirutin, mainly in peel and pulp
2. Carotenoids : beta-carotene, lutein, zeaxanthin
• Uses :
1. Nutritional : Major dietary source of vitamin C for immunity. Folate supports pregnancy.
2. Pharmaceutical : Hesperidin extracted from peel for capillary strengthening and venotonic drugs.
3. Therapeutic : Traditionally used for scurvy, colds, and constipation.
4. Food Industry : Juices, concentrates, marmalade, candy. Peel used for zest, pectin, and essential oil. Dried powder in supplements

**6. Lemon Powder**

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• Synonyms : Lemon, Baramas , Nimbu, Neebu , Limbu
• Biological Source : The fresh ripe fruit of Citrus limon (L.)
• Family: Rutaceae
• Nutrition : Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins : Vitamin C ,Folate (B9) ,Vitamin B1 ,Vitamin B6 Vitamin A
• Minerals: Potassium ,Calcium ,Magnesium ,Phosphorus, Iron
• Antioxidants & Phytochemicals
1. Flavonoids : eriocitrin, hesperidin, diosmin,
2. Citric Acid :major organic acid responsible for sour taste
3. Limonoids : limonin, nomilin
4. Coumarins :bergapten, psoralen
5. Essential Oil: 0.3–0.5% – d-limonene 65–70%, alpha-pinene, gamma-terpinene
• Uses :
1. Nutritional : Rich vitamin C source for immunity and iron absorption. Low calorie, used in detox water and weight management
2. Pharmaceutical : Citric acid used as acidulant, preservative, and effervescent agent. Lemon oil used as flavoring in medicines
3. Therapeutic : Traditionally used for scurvy, sore throat, indigestion, and nausea. Flavonoids studied for antioxidant and antimicrobial effects
4. Food Industry : Juice for beverages, pickles, flavoring. Peel for zest, pectin, candied peel.

**7. Mango Powder**

• Synonyms : Mango, Aam , Amba
• Biological Source : The fresh ripe fruit of Mangifera indica L. Also known as King of Fruits.
• Family : Anacardiaceae
• Nutrition : Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins :Vitamin C ,Vitamin A ,Folate (B9) ,Vitamin E ,Vitamin K Vitamin B6
• Minerals: Potassium ,Copper ,Magnesium ,Calcium ,Phosphorus
• Antioxidants & Phytochemicals :
1. Carotenoids :beta-carotene, lutein, zeaxanthin, alpha-carotene.
2. Polyphenols : mangiferin, gallic acid, catechins, quercetin, mainly in peel and kernel
3. Vitamin C : Major water-soluble antioxidant
4. Enzymes : Amylases that help break down complex carbs
• Uses
1. Nutritional : Excellent source of provitamin A for eye health. Vitamin C + copper support collagen and immunity. Folate supports pregnancy

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2. Pharmaceutical : Mangiferin from leaves/bark studied for antidiabetic, anti-inflammatory effects.
3. Therapeutic : Traditionally used for heat stroke as aam panna, digestion issues with unripe mango, and general nourishment.
4. Food Industry : Pulp for juices, nectar, aamras, jams, ice cream, pickles, chutney. Dried slices as amchur powder.

**8. Beetroot Powder**

• Synonyms : Beetroot, Beet, Garden Beet, Chukandar
• Biological Source : The fleshy taproot of Beta vulgaris subsp. vulgaris .
• Family: Amaranthaceae
• Nutrition: Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins: Folate (B9) ,Vitamin C,Vitamin B6 ,Niacin (B3),Riboflavin (B2)
• Minerals: Potassium ,Manganese ,Iron ,Magnesium ,Phosphorus ,Copper
• Antioxidants & Phytochemicals:
1. Betalains : betacyanin, betaxanthin. Gives deep red color and antioxidant activity
2. Nitrates : converted to nitric oxide in body, improves blood flow.
3. Phenolic Acids : Gallic acid, ferulic acid, rutin
• Uses:
1. Nutritional : High folate supports pregnancy and red blood cell formation. Nitrates improve exercise performance and lower blood pressure
2. Pharmaceutical : Beet juice studied for cardiovascular health and endurance. Betalains investigated for anti-inflammatory and hepatoprotective effects
3. Therapeutic : Traditionally used for anemia due to iron + folate. Juice used to detox liver and improve stamina
4. Food Industry: Used in salads, soups, juices, pickles. Natural red coloring agent for foods and supplements
5. Cosmetic : Beetroot extract used in lip tints and face packs for natural color and hydration. High antioxidant content helps skin glow

**9. Spinatch Powder**

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• Synonyms: Spinach, Palak
• Biological Source: The fresh leaves of Spinacia oleracea L.
• Family: Amaranthaceae
• Nutrition: Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins: Vitamin K ,Vitamin A ,Folate (B9) ,Vitamin C ,Vitamin E Vitamin B6
• Minerals: Iron ,Magnesium ,Potassium ,Calcium ,Manganese
• Antioxidants & Phytochemicals:
1. Carotenoids : lutein, zeaxanthin, beta-carotene. Lutein is key for eye health
2. Flavonoids : quercetin, kaempferol, apigenin
3. Oxalic Acid : binds minerals, reduced by cooking
4. Nitrates: High levels, similar to beetroot for nitric oxide production
• Uses:
1. Nutritional : Top plant source of iron + folate for anemia prevention. Vitamin K and calcium support bone health.
2. Pharmaceutical : Extracts studied for antioxidant, anti-inflammatory, and blood pressure lowering effects due to nitrates
3. Therapeutic: Traditionally used to treat anemia, constipation, and as a cooling food.
4. Food Industry : Used fresh in salads, cooked in curries, soups, smoothies, purees.

**10. Moringa Leaves Powder**

• Synonyms: Moringa Powder, Drumstick Tree Powder, Horseradish Tree Powder, Sahjan Patta Powder, Munga Powder, Shevga Patta Powder
• Biological Source:
- Dried and ground leaves of Moringa oleifera Lam.
• Family : Moringaceae
• Nutrition: Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins: Vitamin A, Vitamin C ,Folate (B9) ,Vitamin E ,Vitamin K Vitamin B6
• Minerals: Calcium, Iron ,Potassium, Magnesium ,Phosphorus ,Zinc
• Antioxidants & Phytochemicals:
1. Polyphenols : quercetin, kaempferol, chlorogenic acid .
2. Isothiocyanates : Niazimicin, niazirin – studied for anti-inflammatory and anticancer effects .
3. Flavonoids : High in myricetin and catechins
4. Glucosinolates : Unique to moringa, contribute to pungent taste and bioactivity.

• Uses:
1. Nutritional : One of the most nutrient-dense plant foods. High plant protein, iron, calcium, and vitamin A.
2. Pharmaceutical : Studied for blood sugar control, cholesterol lowering, anti-inflammatory effects.
3. Therapeutic : Traditionally used for anemia, lactation support, joint pain, and digestion.
4. Food Industry : Added to smoothies, soups, chapati dough, energy bars, supplements.

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**11. Fenugreek Seeds Powder**

• Synonyms: Fenugreek Powder, Methi Powder , Methi Powder
• Biological Source: Dried ripe seeds of Trigonella foenum-graecum L.
• Family: Fabaceae.
• Nutrition: Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins: Vitamin B1 (Thiamine) ,Vitamin B2 (Riboflavin) Vitamin B3 (Niacin) ,Folate (B9) ,Vitamin A ,Vitamin C
• Minerals: Iron ,Manganese ,Magnesium ,Phosphorus ,Potassium ,Calcium Zinc
• Antioxidants & Phytochemicals:
1. Saponins : diosgenin, protodioscin. Responsible for bitter taste and hormone-like activity
2. Alkaloids : Trigonelline, choline – linked to blood sugar modulation
3. Flavonoids : Apigenin, luteolin, quercetin derivatives
5. 4-Hydroxyisoleucine : Unique amino acid studied for insulin sensitizing effects.
• Uses:
1. Nutritional : Good source of fiber, iron, and plant protein.
2. Pharmaceutical : Extensively studied for blood sugar control in type 2 diabetes.
3. Therapeutic : Traditionally used in Ayurveda for digestion, lactation, menstrual cramps, and appetite stimulation.

**12. Watermelon Seeds Powder**

• Synonyms: Watermelon Seed Powder, Magaz Powder ,Tarbooj Beej Powder
, Kalingsha Beeja Powder .
• Biological Source :Dried and ground seeds from the fruit of Citrullus lanatus (Thunb.) Matsum. & Nakai
• Family: Cucurbitaceae
• Nutrition: Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins: Vitamin B1 (Thiamine),Vitamin B2 (Riboflavin) ,Niacin (B3) Folate (B9) ,Vitamin E
• Minerals: Magnesium ,Phosphorus ,Zinc ,Iron ,Potassium ,Copper Manganese
• Antioxidants & Phytochemicals :
1. Citrulline : amino acid that converts to arginine, supports nitric oxide
2. Cucurbitacin E:Trace amounts studied for anti-inflammatory effects


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3. Lycopene : Present in small amounts, especially from red-fleshed watermelon seeds
4. Phytosterols : β-sitosterol, stigmasterol linked to cholesterol management

• Uses:

1. Nutritional : High in plant protein, healthy fats, and magnesium. Good plant-based source of zinc and iron.
2. Pharmaceutical : Citrulline from seeds studied for blood pressure, erectile function, and athletic performance.
3. Therapeutic : Used in Unani and Ayurveda for urinary tract health and as a mild diuretic.
4. Food Industry : Used in thandai, halwa, kheer, and as garnish in Indian sweets. Added to smoothies, protein powders, and trail mixes.
5. Cosmetic : Seed oil and powder used in face packs for hydration and skin elasticity. High linoleic acid content helps with moisturizing and skin barrier repair .

**13. Flex Seeds Powder**

• Synonyms : Flaxseed Powder, Linseed Powder ,Alsi Powder, Tisi Powder , Javsa Powder .
• Biological Source : Dried and ground seeds of Linum usitatissimum L.
• Family : Linaceae
• Nutrition: Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins : Thiamine (B1) ,Folate (B9) ,Vitamin E ,Niacin (B3) ,Vitamin B6
• Minerals : Manganes, Phosphorus ,Magnesium ,Copper, Selenium,Iron
• Antioxidants & Phytochemicals:

1. ALA (Alpha-Linolenic Acid) : omega-3 fatty acid
2. Lignans : secoisolariciresinol diglucoside. Highest plant source of lignans, phytoestrogens with antioxidant effects
3. Mucilage : Soluble fiber that forms gel in water, aids digestion and satiety.
4. Cyclolinopeptides : Cyclic peptides with immune-modulating properties

• Uses:

1. Nutritional : Top plant source of omega-3 ALA for heart and brain health
2. Pharmaceutical : Studied for lowering LDL cholesterol, improving insulin sensitivity, and reducing inflammation.
3. Therapeutic : Traditionally used as mild laxative due to mucilage. Used for constipation, hot flashes in menopause .
4. Food Industry : Used as egg replacer in vegan baking, added to smoothies, rotis, oats, and energy bars.
5. Cosmetic : Powder in face masks for hydration and to reduce skin inflammation due to omega-3s.

**14. Chia Seeds Powder**

• Synonyms: Chia Powder , Chia Beej Powder,
• Biological Source : Dried and ground seeds of Salvia hispanica L.
• Family: Lamiaceae
• Nutrition: Energy, Water , Carbohydrates , Dietary Fiber , Protein , Fat .
• Vitamins : Thiamine (B1), Riboflavin (B2) ,Niacin (B3), Folate (B9) Vitamin E
• Minerals: Calcium ,Phosphorus, Magnesium ,Manganese ,Potassium, zinc

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• Antioxidants & Phytochemicals:
1. ALA (Alpha-Linolenic Acid) :plant omega-3, slightly lower than flax but very stable
2. Chlorogenic Acid : Phenolic acid with antioxidant and blood sugar regulating effects
3. Caffeic Acid : Antioxidant that helps prevent oxidative rancidity of the fats
4. Quercetin: Flavonoid with anti-inflammatory properties
5. Mucilage: Soluble fiber that absorbs 10-12x its weight in water, forms gel
• Uses:
1. Nutritional : Excellent source of plant omega-3, fiber, and calcium. Mucilage slows digestion, helps with satiety and blood sugar control
2. Pharmaceutical: Studied for lowering blood pressure, improving lipid profile, and supporting weight management due to high fiber and gel formation
3. Therapeutic : Used for constipation, hydration, and sustained energy. Aztecs used it as "running food". Helps maintain electrolyte balance when gelled
4. Food Industry: Used in puddings, smoothies, baked goods, energy bars. Acts as thickener and egg replacer. Powder blends better than whole seeds in drinks
5. Cosmetic : Chia gel used in face masks for hydration and skin barrier repair. Omega-3 and antioxidants help reduce skin inflammation and dryness

**Literature Review**

• The study by Gattani SG, Khabiya SS , Amrutkar JR , In AN ECHO TECHNICAL NOTE (2005 ) et. al. Moringa Leaf Powder can be added to any food or beverage and it will increase the vitamin, mineral and protein content. For healthy individuals, a few spoonfuls of Moringa Leaf Powder can be added to any meal to make it more nutritious. Since the nutrient content of Moringa Leaf Powder decreases if exposed to heat, add the powder after the food or drink has been prepared, just before serving. Moringa Leaf Powder has the greatest impact on those who are more vulnerable: malnourished children, pregnant or lactating women, children at weaning age, HIV/AIDS patients, and the elderly. Malnourished children ages 1-3 years should consume three rounded tablespoons (25g) of Moringa Leaf Powder each day. Pregnant or lactating women should consume six rounded tablespoons (50g) of Moringa Leaf Powder each day.

• Durga Shankar Bunkar , Anima Anand , Kamalesh Kumar Meena , S. K. Goyal and V. K. Paswan from phytomedicine Int. Journal (2012) et.al, The fresh beetroot (B. vulgaris) analyzed for moisture, protein, fat, ash, and betalain . The results were different to proximate chemical composition of fresh beetroots per 100 gm as calories 43 ± 1.50 kcal, 88 ± 1.50% moisture content, 9.6 ± 2.20 g carbohydrate, 1.96 ± 0.84 g protein, 0.2 ± 0.02 g fat, 2.8 ± 0.40 g, fibre, and 1.18 ± 0.62 g iron content. A small variation is observed due to climatic condition, soil property and growing condition, harvesting period, maturity stage, agro-ecological condition and temperature used for drying. The yield of beetroot powder was 10 to 12 g per 100 gm of fresh beetroot. Lack of differences in dry matter content in roots of red beet produced by various technologies was reported by Sikoraet al. (2010) and Kazimierczak et al. (2011).Fatemeh Haidari.

• Nasrin Banaei-Jahromi ,Mehrnoosh Zakerkish and Kambiz Ahmadi in Nutrition Journal (2020) et. al, The flaxseed group showed a significant reduction in body weight, insulin concentration, Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), Triglycerides (TG), high-sensitivity C-Reactive Protein (hs-CRP), and leptin and an increase in Quantitative Insulin-Sensitivity Check Index (QUICKI), High Density Lipoprotein (HDL), and adiponectin compared to the baseline ($p < 0.05$). Flaxseed supplementation also led to a significant reduction in insulin concentration, HOMA-IR, TG, hs-CRP, Interleukin 6 (IL- 6), and leptin and an increase in QUICKI, HDL, and adiponectin compared to the control group ($p < 0.05$). No significant changes were observed in other parameters.

• Beni Lestari, Edy Meiyanto , in ISCC (2018) et. al,

In the recent years, pumpkin seeds have a large range of application as a food or herbal medicine. Those waste streams are valuable and can be utilized for food products and/or nutraceutical products. They can be consumed as a snack,

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salads or breakfast cereal in the roasted form (salted or not). In addition, they could be used in baking as the excellent ingredients of bread or cakes. Moreover, their oil is excellent and could gain acceptance as edible oil and additive component in food, pharmaceutical and cosmetic industries. Pumpkin seeds oil is useful for frying, cooking, baking and salad dressing. Supplement from pumpkin seeds could be developed in the form of a soft capsule. In cosmetic industries, they usually use for skin care products such as anti-aging, free-radical scavenging, skin protection and hair care products such as hair growth stimulants and emollients. The consumption of pumpkin seeds in the oil form or roasted pumpkin seeds is proved to exhibit several positive health effects.

• Yakindra Prasad Timilsena , Raju Adhikari , Colin J. Barrow , Benu Adhikari , in ESILVER , Food Chemistry, (2016) et. al, Chia seed protein isolate (CPI) powders obtained from spray, freeze and vacuum drying differed significantly in terms of physical, structural and functional properties; however, these drying methods did not alter the chemical composition. The spray-dried CPI showed the highest solubility, foaming capacity and foam stability and the lowest surface hydrophobicity among the spray, freeze and vacuum-dried CPI powders. The vacuum-dried CPI had the highest oil absorption capacity and surface hydrophobicity

but lowest solubility and foaming properties. The solubility,

foaming capacity and foam stability of these powders were lowest at the isoelectric point (pI = 3.0) of CPI and increased at higher and lower pH values. The differences in solubility, foaming properties, surface hydrophobicity and oil and water absorption capacities of spray, freeze and vacuum-dried CPI powders were also found to be related to the degree of denaturation of the protein. The structural change was highest in vacuum-dried CPI, which resulted in the poorest solubility and foaming properties. The proportion of b-sheet was decreased and that of b-turn and random coil increased in vacuum dried CPI due to denaturation. These findings on the effects of drying methods on the functional properties of CPI will help broaden its application as a protein ingredient.

• Muhammad Waseem ,Saeed Akhtar ,Muhammad Faisal Manzoor, Asif A. Mirani ,Zulfiqar Ali ,Tariq Ismail , Nazir Ahmad, Emad Karrar , in Wiley (2020) et. al,

Fresh leaves of spinach were subjected to preliminary operations such as sorting, grading, washing, and dirt removal. Leaves were dipped in 40 ppm sodium hypochlorite (NaOCl3) solution for 30 min. Residues of sodium hypochlorite were removed by subsequent washing of shredded spinach leaves with potable water. Drying of processed spinach leaves was carried out to 15%–17% moisture contents in a cabinet dryer (PAKFVS-40T) at 45 ± 2°C. Dehydrated leaves were ground to 72 mm mesh size in a heavy-duty grinder.

Spinach powder thus obtained was packed in airtight polyethylene bags and stored at 4–6 ± 2°C for further experimentation.

• Nimesh Chauhan , K.R. Jethva in Indian Journal of Science (2016), et, al.

The weight of selected banana fruits ranged between 98 to 120 gm. The maximum and minimum diameter of banana fruits ranged from 35.00 to 41.00 mm and 31.00 to 35.00 mm. The pulp to peel ratio for banana fruits was ranges from 1.27 to 1.43. Carbohydrate content of dehydrate the banana powder after dehydration in Tray dryer with perforated plates possessed significantly higher amount (78%) at 80˚C temperature for 7mm slices. The fat content was highest in the .Tray dryer with solid plates at 80˚C temp. for 7mm Slices. Ash content of the eighteen samples was in the range of 4.1 to 5.12 % .The ash content was highest in the oven at 80˚C for 7mm slices and tray dried at 75˚C for 7mm slices samples. The 7-mm slices dried at 75 ˚C in Multi- purpose tray dryer have obtained the highest sensory score within the experimental range of different dryers. It can be concluded from the study that multi-purpose tray dryer best suitable for drying of banana slices to get good quality powder.

• G.R. Chegini , B. Ghobadian , from the book of drying technology (2005) et., al., Based on a full factorial experimental design, the effects of the feed ratio, atomizer speed, and inlet air temperature on properties of spray-dried orange juice powders were investigated. The results indicate that increasing inlet air temperature increases the particle size, average time of wettablity, and insoluble solids and decreases the bulk density and moisture content of the powder. Increasing atomizer speed results in increasing the bulk density and average time of wettablity of powder and decreases the particle size, moisture content, and insoluble solids of powder. Increase in feed flow rate increases the

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bulk density, particle size, and moisture content of the powder and decreases the average time of wettablity and insoluble solids of powder. With multivariable regression analysis the relationships between physical properties of orange juice powder and operating parameters with high coefficient were obtained.

**AIM & OBJECTIVES**

Aim :- To formulate and evaluate a multivitamin and
multimineral powder prepared from natural fruit and seed powder.

Objectives :-

1. To formulate a multivitamin and multimineral powder using powders of fruits and seeds.
2. To select suitable natural ingredients rich in vitamins, minerals, antioxidants, and nutrients.
3. To evaluate the prepared powder for organoleptic properties such as color, odor, taste, and appearance.
4. To evaluate physicochemical parameters including bulk density, tapped density, angle of repose, moisture content, and pH.
5. To determine the nutritional content of the formulation such as vitamins, minerals, and antioxidant activity.
6. To study the solubility and dispersibility of the powder in water and milk.
7. To improve patient compliance by developing a palatable and easy-to-consume nutritional supplement.
8. To carry out stability studies of the optimized formulation under suitable storage conditions.

**PLAN OF WORK**

Present proposed research work has been planed as follows –

- Literature survey related to multivitamin and multimineral formulations.
- Selection of suitable fruits, seeds, and excipients for formulation of multivitamin and multimineral powder.
- Procurement of raw materials such as fruit powders/extracts, seed powders, and excipients.
- Preparation and processing of fruit and seed powders/extracts.
- Preliminary studies of selected ingredients and excipients.
- Pre-formulation studies including organoleptic evaluation and compatibility studies.
- Formulation and optimization of multivitamin and multimineral powder.
- Evaluation of prepared powder for the following parameters:

a. Color, odor, and taste
b. Bulk density and tapped density
c. Angle of repose
d. Moisture content
e. pH determination
f. Solubility and dispersibility
g. Nutritional analysis
h. Flow properties
i. Stability studies

**Experimental Work**

**1. Pre-formulation Studies of Various Powder Used :**

Pre-formulation is the study of the physical and chemical characteristics of the medicinal ingredient both by itself and in combination with excipients. The initial stage in the logical development of a pharmacological substance's dosage form is pre-formulation research

Pre-formulation research aims to create a portfolio of data regarding the drug's constituents so that formulation can be developed with the help of this data. Pre-formulation studies are intended to find the excipients and physicochemical

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characteristics that could affect the final product's pharmacokinetic-biopharmaceutical characteristics, manufacturing process, and formulation design. Thus, the program's objectives are
To ascertain its kinetic release rate profile. Therefore, physical test determination and compatibility studies are part of a pre-formulation study on the medication sample that was collected.

**1.1. Description**

The powder was analyzed for color, odour and taste. All the analysis of powder was done manually like colour is observed in light and in normal room temperature . Odour was done on analysis of smell which is also done in room temperature . Taste was done on the basis of simply manuallty testing through mouth .

**1.2 Solubility Characteristics**

A semi quantitative determination of solubility can be made by adding a solute in small incremental amount to fixed volume of solvents, drinking water , milk . After each addition, the system is vigorously shaken and examined usually for any undissolved particles .

**2. Procedure for Preparation of Multivitamin and Multimineral Powder.**

**Step 1: Collection of Raw Materials**

Fresh fruits, vegetables, and seeds were collected from the local market. Fruits Used : Apple ,Mango ,Banana ,Pineapple ,Papaya ,Lemon Vegetables Used: Beetroot ,Spinach ,Moringa leaves
Seeds Used : Pumpkin seeds ,Chia seeds ,Flax seeds ,Fenugreek seeds, Watermelon seeds.

**Step 2: Cleaning and Washing**

All fruits and vegetables were washed thoroughly with purified water to remove dust, dirt, and impurities.
Seeds were cleaned separately to remove foreign particles and unwanted materials. Excess water was removed using clean cloth or tissue paper.

**Step 3: Peeling and Cutting**

Fruits such as banana, pineapple, papaya, and mango were peeled properly. Fruits and vegetables were cut into small uniform slices using slicer to facilitate drying. Beetroot and apple were sliced into thin pieces for faster drying.

**Step 4: Drying Process**

The sliced fruits and vegetables were dried using tray dryer/shade drying/sun drying. Drying was carried out at 45–50°C until complete removal of moisture. Seeds were also dried separately to avoid fungal growth and moisture retention. Drying was continued until crisp and brittle material was obtained.

**Step 5: Grinding and Powder Preparation**

The dried materials were ground separately using grinder or pulverizer. Fine powders of fruits, vegetables, and seeds were prepared.
Powders were passed through sieve no. 60 to obtain uniform particle size. Coarse particles remaining on sieve were reground.

**Step 6: Preparation of Powder Blend**

Required quantities of all fruit powders, vegetable powders, and seed powders were accurately weighed.
All powders were mixed uniformly using geometric mixing method in a clean dry blender.
Excipients such as:
Sucrose (sweetening agent) Sodium benzoate (preservative) were added to the powder blend.

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Mixing was continued for 10–15 minutes to obtain a homogeneous blend.

**Step 7: Sieving**

Final powder blend was passed through sieve no. 60 again to ensure uniform mixing and particle size distribution. Agglomerates and lumps were removed.

**Step 8: Packaging**

Prepared multivitamin powder was filled into airtight containers or sachets. Containers were labeled properly with formulation details and storage conditions. The formulation was stored in cool and dry place away from moisture and sunlight.

Table No. 3 : Formulation For Multivitamin Powder In Water

| Sr. No. | Ingredients | Batch A (grams) | Batch B (grams) | Batch C (grams) | Batch D (grams) |
|---|---|---|---|---|---|
| 1. | Banana powder | 8 | 8 | 8 | 8 |
| 2. | Pineapple powder | 4 | 4 | 4 | 4 |
| 3. | Citrus fruits powder | 6 | 6 | 6 | 6 |
| 4. | Mango powder | 8 | 8 | 8 | 8 |
| 5. | Papaya powder | 6 | 6 | 6 | 6 |
| 6. | Fenugreek seeds powder | 6 | 5.5 | 5 | 4 |
| 7. | Spinach powder | 5 | _ | 3 | 2 |
| 8. | Beetroot powder | _ | 2.5 | 4 | 4 |
| 9. | Sucrose powder | 3 | 3 | 3 | 3 |
| 10. | Sodium benzoate | 4 | 4 | 4 | 4 |
| | Total | 50 | 50 | 50 | 50 |

Table No. 4 : Formulation For Multivitamin Powder In Milk

| Sr. No. | Ingredients | Batch A (grams) | Batch B (grams) | Batch C (grams) | Batch D (grams) |
|---|---|---|---|---|---|
| 1. | Banana powder | 10 | 10 | 10 | 10 |
| 2. | Watermelon seeds powder | 6 | 6 | 6 | 6 |
| 3. | Fenugreek seeds powder | 4 | 4 | 4 | 4 |
| 4. | Mango powder | 2 | 2 | 2 | 2 |
| 5. | Pumpkin seeds powder | 3 | 3 | 3 | 3 |
| 6. | Papaya powder | 4 | 4 | 4 | 4 |
| 7. | Flex seeds powder | 3 | 3 | 3 | 3 |
| 8. | Chis seeds powder | 3 | 3 | 3 | 3 |
| 9. | Apple powder | 5 | 4 | 2 | 2 |
| 10. | inatch powder | 3 | 5 | _ | 2.5 |
| 11. | oringa leaves powder | 3 | _ | 6 | 2.5 |
| 12. | Beetroot powder | 2 | 4 | 5 | 6 |
| 13. | Sodium benzoate | 2 | 2 | 2 | 2 |
| | Total | 50 | 50 | 50 | 50 |

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Table No. 5 : Formulation Of Multivitamin Powder For Pregnant Women In Milk

| Sr. No. | Ingredients | Batch A (grams) | Batch B (grams) |
|---|---|---|---|
| 1. | Spinatch Powder | 5 | 5 |
| 2. | Apple powder | 2 | 2 |
| 3. | Watermelon seeds powder | 6 | 6 |
| 4. | Banana powder | 10 | 10 |
| 5. | Mango powder | 2 | 2 |
| 6. | Pumpkin seeds powder | 3 | 3 |
| 7. | Flex seeds powder | 4 | 4 |
| 8. | Chis seeds powder | 4 | 4 |
| 9. | Pineapple powder | 2 | 2 |
| 10. | Moringa leaves powder | 2 | 8 |
| 11. | Beetroot powder | 8 | 2 |
| 12. | Sucrose powder | 1 | 1 |
| 13. | Sodium benzoate | 1 | 1 |
| | Total | 50 | 50 |

**3. Pre-formulation study:**

Bulk Density (Db):

The mass of the powder was divided by the bulk volume in cm' to determine the loose bulk density. A 25 ml graduated cylinder was carefully filled with the 10 g sample. After recording the powder's volume, the bulk density was computed. It was computed using the following equation

$$Df = \frac{M}{Vp}$$

Where,

D = Loose bulk density M=Weight of samples in grams

Vp= Final volumes of granules in $cm^3$.

Tapped Density (D):

The mass of a powder was divided by the tapped volume in centimeters to determine the tapped bulk density. A 25 ml graduated cylinder was caretully iilled with the 10 g sample. The cylinder was dropped 100 times from a height of 1 inch onto a hard wood surface at 2-second intervals. The final tapped volume in cm' of the sample contained in the cylinder was then divided by the sample weight in grams to determine the tapped bulk density of each formulation. It was computed using the following equation.

Formula :

Tap Density = Weight of powder
Volume after tapping

Angle of repose :

The flow characteristics of solids have been described using the angle of repose. One property associated with interparticulate friction, or resistance to particle movement, is angle of repose.

This is the greatest angle that can exist between the granule or powder pile's surface and the horizontal plane. $\tan \Theta = h / r$

$\Theta = \tan\text{-}1h / r$ Where,

$\Theta$ = Angle of repose. h = Height.

r = Radius

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A funnel was attached over the platform at a height of about 2 cm. The loose powder was gradually moved along the funnel's wall until a powder cone formed. Measure the height of the powder cone and the radius of the powder heap to find the angle of repose.

| Flow Property | Angle of Repose (degrees) |
|---|---|
| Excellent | 25-30 |
| Good | 31-35 |
| Fair-aid not needed | 36-40 |
| Passable may hang up | 41-45 |
| Poor-must agitate, vibrate | 46-55 |
| Very poor | 56-65 |
| Very, very poor | >66 |

**Result and Discussion**

1. Characterization of Multivitamin and Multimineral Powders.

1. Organoleptic Characterization :

The prepared multivitamin and multimineral powder was evaluated for organoleptic properties such as colour, odour, taste, and appearance .

The formulation showed acceptable characteristics and was found suitable for oral administration with water or milk .

**Characterization For Multivitamin Powder Soluble In Water :**

| Sr. no. | Test | Observation |
|---|---|---|
| 1. | Colour | Cream colour |
| 2. | Odour | Pleasant fruity odour |
| 3. | Taste | Sweet |
| 4. | Appearance | Fine free flowing powder |
| 5. | Texture | Smooth and uniform |

**Characterization For Multivitamin Powder Soluble In Milk :**

| Sr. no. | Test | Observation |
|---|---|---|
| 1. | Colour | Creamy greenish |
| 2. | Odour | Pleasant and nutritive odour |
| 3. | Taste | Sweet and palatable |
| 4. | Appearance | Fine homogenous powder |
| 5. | Texture | Smooth and soft |

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**Characterization For Multivitamin Powder For Pregnant women Soluble In Milk :**

| Sr. no. | Test | Observation |
|---|---|---|
| 1. | Colour | Dark Greenish |
| 2. | Odour | Characteristic herbal fruity odour |
| 3. | Taste | Sweet with slightly herbal |
| 4. | Appearance | Fine uniform powder |
| 5. | Texture | Smooth and free flowing |

**2. Solubility analysis :**

The solubility characteristics of the prepared powder were studied in mil and water . The formulation showed better dispersion and solubility in milk as compared to water due to the presence of fruit and seeds powder.

**Solubility Analysis Of Multivitamin Powder In Water :**

The formulation shows satisfactory dispersion in water with acceptable consistency and good appearing colour which is reddish brown and no lump formation.

| Sr. no. | Formulation | Observation |
|---|---|---|
| 1. | Batch A | Not completely soluble |
| 2. | Batch B | Partially soluble |
| 3. | Batch C | Soluble and not pleasant appearance |
| 4. | Batch D | Completely soluble with pleasant appearance |

**Solubility Analysis Of Multivitamin Powder In Milk :**

The formulation showed better solubility of fruits powder and seeds powder in milk , the formulation also showed a rose red colour of milk which males it mare pleasant and better soluble in milk.

| Sr. no. | Formulation | Observation |
|---|---|---|
| 1. | Batch A | Not soluble |
| 2. | Batch B | Partially soluble with high sedimentation |
| 3. | Batch C | Partially soluble with less sedimentation |
| 4. | Batch D | Completely soluble |

**Solubility Analysis Of Multivitamin Powder In Milk For Pregnant Womens :**

The formulation prepared for pregnant women showed good solubility, uniform mixing and acceptable consistency suitable for nutritional supplementation.

| Sr. no. | Formulation | Observation |
|---|---|---|
| 1. | Batch A | Completely soluble |
| 2. | Batch B | Completely soluble but unpleasant appearance. |

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**2. Formulation and development :**

**□ Preparation Of Multivitamin Powder Soluble In Water :**

The prepared water soluble powder showed good solubility, pleasant taste, smooth texture, and acceptable appearance. Banana powder provided potassium and carbohydrates, orange powder supplied vitamin C, while beetroot and spinach powder enhanced iron and mineral content. Fenugreek seed powder improved digestion and nutritional value.

Batch D gives completely soluble preparation which consists of verity of vitamins , minerals and anti-oxidants. It also gives reddish colour appearance due to presence of beetroot . So, batch D was more acceptable.

**□ Preparation Of Multivitamin Powder Soluble In Milk :**

The milk soluble formulation was prepared using fruit powders to administer with milk to enhance calcium and protein content. Banana powder improves energy value and spinach powder contributes iron and minerals.

Milk powder improves taste, nutritional value, and compatibility with milk preparations. Sodium benzoate (2 gm) was incorporated as preservative to prevent microbial growth and maintain stability during storage.

As done in experimental work observation done , and concluded that Batch A and Batch B , having sedimentation which is due to excess quantity of chia seeds , and flex seeds.

So, Batch D was more acceptable.

**□ Preparation Of Multivitamin Powder Soluble In Milk For Pregnant Women :**

The prepared formulation for pregnant women showed good nutritional properties and acceptable organoleptic characteristics. Spinach and beetroot powder provided iron and folic acid, banana powder supplied potassium . The formulation was found suitable for nutritional supplementation during pregnancy.

Spinach and beetroot powder help in improving hemoglobin level . Banana powder provides energy and potassium required for proper body function.

Sodium benzoate (1 gm) was used as preservative to improve stability and prevent microbial contamination. The formulation is suitable as nutritional supplementation for pregnant women and may help in maintaining proper nutritional balance during pregnancy.

**3. Evaluation Parameters For :**

□ Multivitamin Powder Soluble In Water :

| Formulation | Bulk density | Tapped density | Angle of repose | Carr's index | Hausner ratio |
|---|---|---|---|---|---|
| Batch A | 0.419 ±0.01 | 0.502 ± 0.01 | 27.8 | 18.00 | 1.21 |
| Batch B | 0.432 ± 0.01 | 0.521 ± 0.01 | 28.5 | 17.34 | 1.20 |
| Batch C | 0.404 ± 0.01 | 0.496 ± 0.01 | 29.2 | 18.36 | 1.22 |
| Batch D | 0.425 ± 0.01 | 0.512 ± 0.01 | 28.0 | 17.62 | 1.21 |

**Multivitamin Powder Soluble In Milk :**

| Formulation | Bulk density | Tapped density | Angle of repose | Carr's index | Hausner ratio |
|---|---|---|---|---|---|
| Batch A | 0.442 ±0.01 | 0.532 ± 0.01 | 27.5 | 16.90 | 1.20 |
| Batch B | 0.454 ± 0.01 | 0.541 ± 0.01 | 28.1 | 16.60 | 1.20 |
| Batch C | 0.436 ± 0.01 | 0.529 ± 0.01 | 29.0 | 17.36 | 1.21 |
| Batch D | 0.468 ± 0.01 | 0.552 ± 0.01 | 28.4 | 16.32 | 1.19 |

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**Multivitamin Powder Soluble In Milk For Pregnant Women :**

| Formulation | Bulk density | Tapped density | Angle of repose | Carr's index | Hausner ratio |
|---|---|---|---|---|---|
| Batch A | 0.422 ±0.01 | 0.512 ± 0.01 | 28.3 | 17.60 | 1.21 |
| Batch B | 0.444 ± 0.01 | 0.531 ± 0.01 | 27.9 | 16.90 | 1.20 |

Evaluation parameters mainly focus on flow properties of multivitamin powder, because fruit powders are sticky and seeds powder can be fibrous or oily , they naturally tends toward poor flow property.

**According to angle of repose:**

Low Angle (<30°): Indicates excellent, free-flowing powder. This is the goal for smooth manufacturing and effortless pouring by the consumer.

**According to Carr's Index :**

Low Carr's Index (<20% ): Means the particles are already efficiently packed and flow freely, ensuring that the volume packaged in the lab remains consistent during storage.

**According to Hausners Ratio :**

Low Hausner Ratio (<1.25): Indicates minimal inter-particle friction. The fruit and seed particles will move together as a cohesive, uniform blend without separating or clumping.

**Summary & Conclusion**

**1. Summary**

The aim of the present work was to formulate and evaluate a nutraceutical multivitamin and multimineral powder prepared from natural fruits, vegetables, and seed powders for oral administration along with Water and Milk . The formulation was designed to provide essential vitamins, minerals, antioxidants, dietary fiber, and bioactive phytochemicals required for maintaining overall health and nutritional balance.

Various fruit powders such as banana, apple, mango, pineapple, papaya, lemon, and citrus fruit powders along with vegetable powders like beetroot, spinach, and moringa leaves powder and seed powders including flax seeds, chia seeds, fenugreek seeds, pumpkin seeds, and watermelon seeds were selected based on their nutritional and therapeutic importance. Excipients such as sucrose and sodium benzoate were used as sweetening and preservative agents respectively. The study was continuous done on formulation of 3 types of powder which should be taken in water and milk and one for pregnant women.

Pre-formulation studies were carried out prior to formulation development.

The prepared powders were evaluated for parameters such as color, odor, taste, solubility, bulk density, tapped density, and angle of repose. Different formulations for administration in water and milk were prepared by geometric mixing method. The raw materials were cleaned, dried at suitable temperature, pulverized, sieved through sieve no. 60, and blended uniformly to obtain a homogeneous powder mixture.

The prepared powders showed acceptable physicochemical characteristics, good flow properties, and uniform particle size distribution. Before experiment all the powders of fruits , seeds and leaves are gone through pre formulation studies like , flow property and solubility check .

The powder dispersed well in water and milk and remained stable under proper storage conditions.

While making formulation addition of various powders are done but it shows lots of solubility defects. Like for water soluble , Batch A excess amount of fenugreek seeds and spinach powder , showed unpleasant colour and bitter taste. Then in Batch B and Batch C, we adjust the amount of fenugreek seeds and spinach powder by decreasing amount of it which is nearly 0.5 to 1 gm and also introduce small quantity of Beetroot 2.5gm . Finally in

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Batch D , by adjusting all the quantity and increasing beetroot to 4 gm. Which made its , pleasant appearance and good taste , So, Batch D is more desirable.

Then , for milk soluble formulation , we add seeds like flex seeds , chia seeds in Batch A, also added Moringa powder and spinach both 3gm. This made it more greenish colour which looks unpleasant. Then in Batch B and Batch C, by adjusting the quantity of moringa and spinach with 2.5gm. beetroot in 6gm. made pleasant colour , and adding less amount of sodium benzoate 2gm. Batch D is more acceptable for milk formulation .

For pregnant women formulation soluble in milk , we skipped papaya powder and fenugreek seeds powder , and increase the quantity of moringa powder and beetroot powder to 8gm. for its , iron and folic acids contents. So its Batch A is more acceptable .

As per the satisfactory evaluation parameters, the Batch D of both water and milk soluble formulation were found to be optimized batch .

## 2. Conclusion

It can be concluded that the formulation and evaluation of multivitamin and multimineral powder using natural fruits, vegetables, and seeds was successfully achieved. The prepared nutraceutical powder formulation provided a rich source of essential vitamins, minerals, antioxidants, dietary fiber, and bioactive compounds required for maintaining good health and preventing nutritional deficiencies.

The formulation method was simple, economical, and suitable for large-scale preparation. The developed powder formulation can be easily administered with water or milk and may serve as a convenient dietary supplement for children, adults, pregnant women, elderly individuals, and nutritionally deficient patients. The presence of natural antioxidants and nutrient-rich ingredients may help improve immunity, digestion, energy levels, and overall body health.

Therefore, the prepared multivitamin and multimineral powder can be considered as a promising nutraceutical formulation with potential applications in pharmaceutical, nutraceutical, and functional food industries.

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