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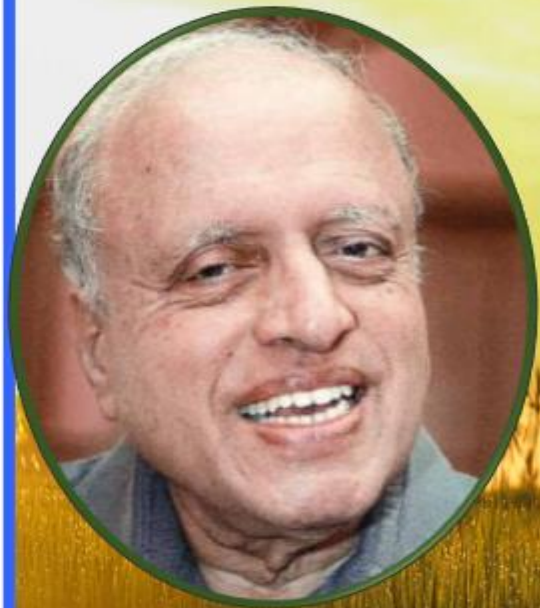

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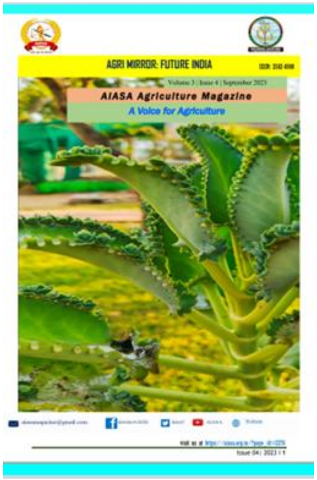

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ELECTROHYDRODYNAMIC DRYING OF FOODS

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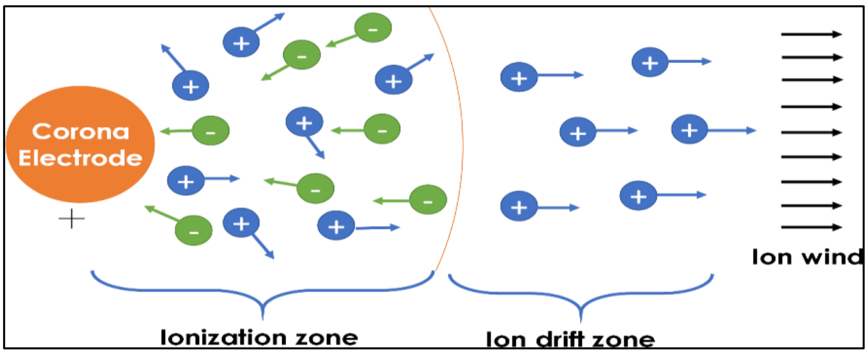
Introduction:

Drying is a simple food preservation technology which has been practiced since long back.It refers to the removal of moisture from the product to improve shelf life, safe storage and to ensure off-season availability of product. There are conventional drying methods such as sun drying and hot air drying and innovative drying techniques like microwave drying, freeze drying. Conventional techniques cause undesirable thermal degradation and loss of sensory and nutritionalproperties. So that researchers are developing innovative and sustainable drying techniques. One such innovative drying technology is electrohydrodynamic drying.

Electrohydrodynamic drying (EHD) is a promising emerging non thermal drying technology involving the interaction of high voltage electric field-generated corona wind with dielectric food material. Compared to other drying systems, EHD drying systems offer lower food production costs, have simpler design and lesser energy consumption along with greater potential for bulk and industrial drying applications. It provides superior quality products with better appearance, flavour, colour, lower shrinkage, higher rehydration ratio and higher nutrient retention. The non-thermal nature of EHD-drying may present a wide range of applications in industrial drying, given its capacity to produce high-quality processed products.

Electrohydrodynamics:

Electro hydrodynamics is a branch of fluid mechanics, dealing with the movement of fluids under the influence of an electric field. The application of HVEF (with frequencies of 50 or 60 Hz for AC, 0 Hz for DC) to an emitting electrode result in the ionization of air particles



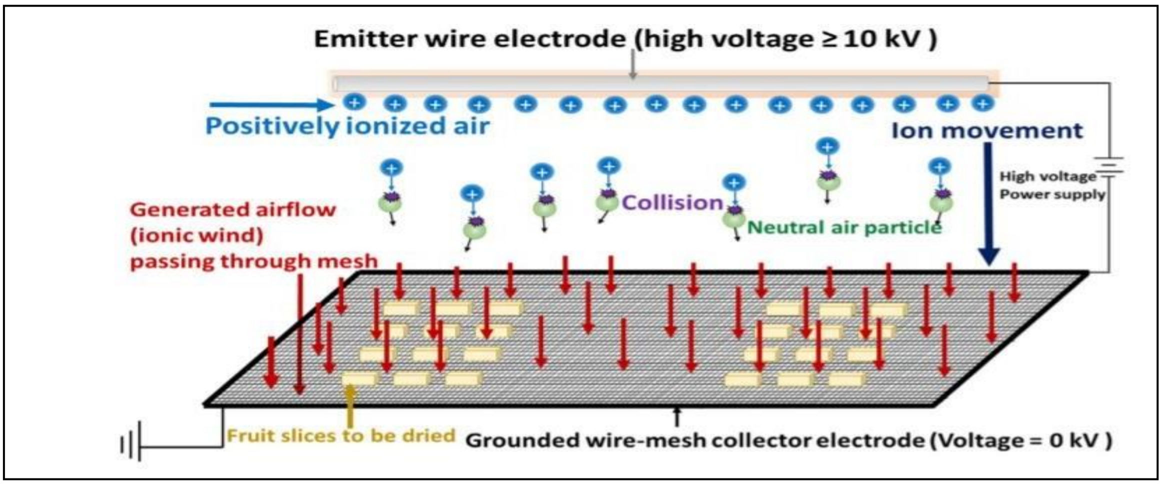
in the surrounding environment adjacent to the electrode. This cloud of unipolar charged particles is repelled by Coulombic forces and this clustered region of charged molecules is also explained as the ionization region. The movement of acquired charged particles leads to an avalanche of ionic wind during which the charged particles collide with neutral molecules, allowing momentum transfer effects. Charged ions are accelerated towards the grounded electrode in the process termed drifting. The movement of neutral particles as a result of a collision with ionized charged particles and this occurs under an electric field that can generate

Fig.1: Generation of ionic wind (Source: Martynenko, 2016)

an appreciable wind called corona wind or electric wind. The uniqness of EHD is generation of ionic wind and occurs under an electric field. Being a versatile approach, the electrohydrodynamic operation covers a broad spectrum of technologies including electrospinning, electro spraying, electro-osmosis, electrohydrodynamic drying and electrohydraulic extractions. The concept of electrohydrodynamic has also been used in the production of various biopolymeric materials. Importantly, the method works excellent for heat-sensitive ingredients including probiotic cultures and in pharmaceutical formulations.

Electrohydrodynamic of foods:

Electrohydrodynamic (EHD) drying is a novel method of nonthermal processing. Electrohydrodynamic (EHD) drying refers to removal of water from the wet material exposed to strong electric field due to aerodynamic action of the so-called corona wind, ionic wind, or



electric wind.

Fig.2: EHD drying mechanism (Source: Onwude et al., 2021)

The generated electric wind impinges on the moisture-laden material placed at the grounded electrode. The transport phenomenon applies to the food surface and the air in motion through a stationary fluid film, resulting in the interference of the diffusion of moisture from the wet product to the bulk airflow. This process disturbs the saturated boundary layer and results in the evaporation of water molecules from the food. Thus, exothermic interaction of the electric field with a dielectric food material result in rapid evaporation of moisture from foods. During the process, water molecules get aligned along the direction of the applied electric field. Since the corona discharge can be produced at room temperature, it results in lowering entropy because of the polarization of water molecules. With the orientation of polar water molecules of the food material in the direction of the applied electric field, there occurs the dissipation of thermal energy due to the disintegration of hydrogen bonds resulting in lowering the entropy of the system. This process lowers the temperature required to dry the food material, making EHD a non-thermal approach when used at ambient conditions without the application of external heat, thereby making it appropriate for drying of heat-sensitive materials. Further, EHD occurs under ambient temperature and pressure conditions, explaining reduced operational costs.

The minimum voltage required for ionization is called “inception voltage” and the maximum voltage resulting in an arc discharge is the “breakdown voltage.”. EHD drying occurs in the range between inception and breakdown voltages.

Electrohydrodynamic (EHD) drying appears to comply with both issues, namely low energy consumption and high product quality, even though it is not a profoundly explored method of drying. In EHD-drying, electric fields of high intensity and standard industrial=domestic frequency (50 or 60 Hz) are applied so as to generate ionized forms of air-constituents within the foodstuff.

Advantages of EHD drying:

a. EHD drying is an effective non thermal drying technique.
b. It is suitable for heat sensitive foods
c. Higher drying rate
d. Due to convective nature of electrically induced ionic wind, EHD is considered as a surfacephenomenon.
e. The convective current generated by ionic wind is 3-4 times efficient than mechanically inducedconvective flow.
f. Less energy consumption
g. Lower carbon emissions
h. Lower shrinkage and higher rehydration capacity
i. Better retention of nutritional content, flavor and colour

Limitations of EHD drying:

a. Drying time is more
b. Knowledge over this drying in commercial field is less.
c. The underlying mechanism of interaction of electric forces induced during EHD is unknown.
d. Prolonged exposure of ionic wind over surface of foods may cause discoloration and hardeningof some solid particulate food materials.
e. Standardization of drying kinetics and drying rate.
f. A more detailed study on the nutritional value of foods after EHD drying is required

CONCLUSION:

Conventional drying technologies can result in significant deterioration of organoleptic and nutritional quality of foods, particularly owing to the use of high drying temperatures. EHD drying is a promising emerging non thermal drying technique. It is well suited for high value foods and those with heat sensitive components. The shrinkage, color degradation, and textural changes are considerably lower in EHD dried foods compared to thermal drying. A scalable EHD dryer should be able to provide dried foods with high nutritional quality, low energy consumption and lower production cost. EHD approach is proven to be energy-efficient and offers significant savings in drying time. It should have less impact on environment. Although EHD has great scope for industrialization further studies and protocols are required for commercialization of this technique.

References:

Martynenko, A. and Kudra, T. (2016). Electrohydrodynamic (EHD) Drying of Grape Pomace. *Journal of Food Engineering*, 17, 123–129.

Onwude, D. I., Iranshahi, K., Martynenko, A. and Defraeye, T. (2021). Electrohydrodynamic drying: Can we scale-up the technology to make dried fruits and vegetables more nutritious and appealing. *Comprehensive Reviews in Food Science and Food Safety*, 20(5), 5283- 5313.

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HI-TECH PRODUCTION SYSTEMS IN KIWIFRUIT

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Abstract

Kiwifruit belongs to the family Actinidiaceae and is the deciduous woody vine. It comprises different species and cultivars that exhibit various characteristics and sensory attributes. Kiwifruit is a rich source of antioxidants such as vitamin C. Thus, consumer preferences have increased worldwide. Kiwifruit production increased by adopting modern technology, which is less environment-dependent, ultimately increasing the quality and productivity of kiwifruit. Hi-tech production includes the precision in the application of micro-irrigation, fertigation, protected cultivation, soil, and leaf nutrient-based fertilizer management, mulching, micropropagation, use of biofertilizers, application of plant growth regulators, vermiculture, high-density planting, hi-tech mechanization, green food, soil-less culture, biological control, etc.

Introduction

It is known as "Chinese gooseberry" and is a deciduous vine fruit crop that is widely grown all around the world. Basically, this crop is mainly cultivated in China, New Zealand, Italy, Japan, Australia, the United States of America, the United States, France, Chile, and Spain. It is a tropical and sub-tropical fruit. Kiwifruit has high medicinal value. Kiwifruit contains a higher nutritional value, vitamin A, vitamin E, and potassium. More consumption of kiwi fruit is better for heart patients.

Climate: The ideal temp for growing kiwifruit is below 38 °C. if the temperature is more than 38 °C may induce sunburn.

Soil Requirement: Well-drained soil requires the application of regular nitrogen, potassium, and phosphorus during its vining stages during its vegetative growth. the best soil pH is 6.3 to 7.3 for maximum production of this fruit crop.

Planting: For commercial kiwi plantations, it is essential to grow these vine plants at a proper distance with a suitable method of propagation by keeping the ideal depth.

Propagation in Kiwi Farming:

- Hard-wood cutting, semi-hard-wood cutting, and softwood cutting are used for cutting nursery plants. Plant growth-promoting rhizobacteria (PGPR) is used to induce the rooting and root growth of semi-hardwood and hardwood kiwifruit stem cuttings. highest rooting ratios were obtained at 47.50% for semi-hardwood stem cuttings from *Bacillus* RC03 and *Bacillus* simplex RC19 treatments and 42.50% for hardwood stem cuttings from Bacillus RC03. The cutting growing season is February to the first week of March or October to November (Erturk *et al.*, 2010).

- Dormancy of hydrated seeds is alleviated by the perception of a period at low temperatures (stratification), but further incubation under fluctuating temperatures (20/30 ◦C) is a requirement for dormancy termination (Lastuvka *et al.*, 2021).
- Planted at the distance of row to row 4 meter and plant to plant 6 meters. Kiwifruit flower is very difficult to pollinate because the flower is not very attractive. It is pollinated by honey bees. Planting time is December to February and the time of planting one male plant and 9 female plants have planted the ratio between the vines for better pollination. Kiwi is the diecious vine and for good fruit production, a male plant is interplanted with the female plant. A rainfall of about 150 cm per year is sufficient.

Use of plant bioregulators (PBRs)

- In the nursery, auxin-containing compounds (NAA and IBA) are used to enhance root formation in woody and herbaceous cuttings. During dormancy, dormancy breaking agents (Dormex, Hi-cane, Citokin and Armobreak) are used to overcome lack of chilling requirements enhancing bud break and fertility. After blooming, auxins, gibberellins (Triclopir, Spray Dunger Global) and cytokinins (Forchlorfenuron) are used to affect fruit morphogenesis. Recently, other new PBRs, such as Jasmonates, were tested in kiwifruit to affect flesh color in fruits of *Actinidia chinensis*, and to reduce water use in both *Actinidia chinensis* and *A. deliciosa*, such as abscisic acid. In post-harvest conditions, the use of molecules able to interfere with ethylene biosynthesis, such as 1-MCP, are suggested to prolong fruit storage and shelf-life (Costa *et al.*, 2010).

Varieties: Abbott, Allison, Bruno, Tomuri, Monty, Hayward etc.

Spacing: T-bar training system and Pergola Training System are mostly followed in kiwifruit. For planting with T-bar training system, the spacing followed row to row is 3.5 m whereas the plant to plant spacing is about 6 m. And for planting with Pergola Training System, the row-to-row planting should be 6 m whereas, the plant-to-plant distance should be 5 to 6 m.

Protection from Wind and Frost

- Grown mostly in the colder areas such as New Zealand, Spain, Australia, USA, France, Chile, Japan, China, etc. It is essential to provide protection to this vine crop from the frost conditions and heavy winds. Natural and artificial wind protection systems have also been adopted in many orchards, especially those at higher altitudes
- In the cold season, plants are dormant, which are able to withstand temp. up to – 12 °C. But it requires protection from such a low temp. heavy frost conditions and winds may lead to complete destruction of the crop.

Irrigation: Crop requires regular supply of water up to three years of the plantation on the main field. Application of organic and inorganic mulching material minimizes the water requirement saves water from evaporation and also control the weeds. Irrigating this crop at 10 days to 14 days of the interval is considered as the best and beneficial for optimum production.

Application of Manure and Fertilizers:

Fertigation systems applied for both fertilization and irrigation. 25 kg of farmyard manure as the basal dose to each plant before planting this crop to the main field. Also, add about 500 gm of the mixture, containing 40 % of Nitrogen, 30 % of potash and phosphorous each, each and every year to the base of the plant up to 5 years of plantation. After five years of the plantation, adding 1 kg of Nitrogen, 0.5 kg of Phosphorous and 1 kg of Potash, every year has excellent results in this fruit production. Crop requires a high amount of Cl because the deficiency of Cl has adverse effects on the plant vegetative growth such as roots and shoots.

Training and Pruning Kiwifruit plants:

Training: These plants, wooden pillars should be fixed on the main field. However, concrete and iron pillars are also used for providing support to these vines. Fix them by keeping a distance of 5 to 6 meters, apart from each other. Construct a structure such as Kniffin system with the health of wire fence or a mess like structure to provide the support to the vines. The pillars should have a height of 1.6 m to 2.1 m, above from the ground. A 2 mm thick and tensile wire should be strung on the top of these fixed pillars.

Pruning: Proper pruning for good fruit production. There is a need for timely removal of unwanted and undesired parts should be removed from the plants to enhance the plant growth and the fruit production in kiwi farming. Cut the canes from male plants, just back to the removed flower wood, just after the flowering season starts.

Kiwi Tree Male and Female Pollination: Dioecious plants, and therefore requires flower pollen to be collected and applied artificially over a wide area of cultivation. For a good pollination this commercial fruit crops, plants about one male plants per 6 to 8 female kiwi plants.

It requires more than 10,000 pollen grains per stigma for healthy pollination. Place some honeybee hives at some distance apart in the orchard. However, it is also possible to pollinate the flowers artificially.

Mechanized technologies

As the kiwifruit industry more commercialized, it is in the interests of the industry to mechanize production, which can promote industrialization and boost industrial value and market prospects. Currently, New Zealand, Italy, Chile, and China are currently conducting research into the mechanism of kiwifruit production, including pollination, harvesting, and grading equipment, as well as detection.

Mechanized kiwifruit production, as well as information collecting and standardisation, are being developed in order to promote precision agriculture and agricultural wisdom in the future.

Processes in the kiwifruit industry

Although the planting stage has been mostly automated, global efforts to resolve issues such as pollination, picking, grading, and other mechanical technical issues have so far failed completely.

The process of artificial pollination is used to pollinate kiwifruit, and it is difficult to achieve a high standard, which is directly related to the size and quality of the fruit. Pollination services have now become a new orchard sector; thus, mechanisation of kiwifruit pollination is increasingly becoming more vital to increase pollination quality using sensors and advanced nozzle systems picking of kiwifruit uses artificial picking widely, which makes it an annual problem for the industry as extra labour is needed to harvest the crop. Finally, the grading classification of kiwifruit size and quality prior to sale determines the sale price (Mu *et al.*, 2018).

Orchard management systems

- Spanish kiwifruit industry depends almost 100% on a single cultivar, 'Hayward' and it is propagated through hardwood cuttings from official nurseries or by micropropagation.
- In the Iberian Peninsula, followed two trellis or support systems, the T-bar and pergola, are common. Pergola was the first to be used in the 1970s, more recently, the T-bar system became more popular, an innovation brought from New Zealand. Plant density has increased to 1000 plants ha^{-1} with 2-3 m between plants in a row. Planting with ratios of 1:8 male to female is widely used today, to that end by alternating rows of female plants with rows with males every two females.

Integrated management systems

It provides observation and production in accordance with specific guidelines, such as the use of organic and chemical fertilizer under the supervision of technical specialists, and the use of chemical herbicides, pesticides, and fungicides to a limited.

Application of hydrogen cyanamide (dormex) only under some circumstances such as mild winter temperatures, to satisfy the minimum chilling requirements for kiwifruit.

Harvesting, postharvest and commercialization management

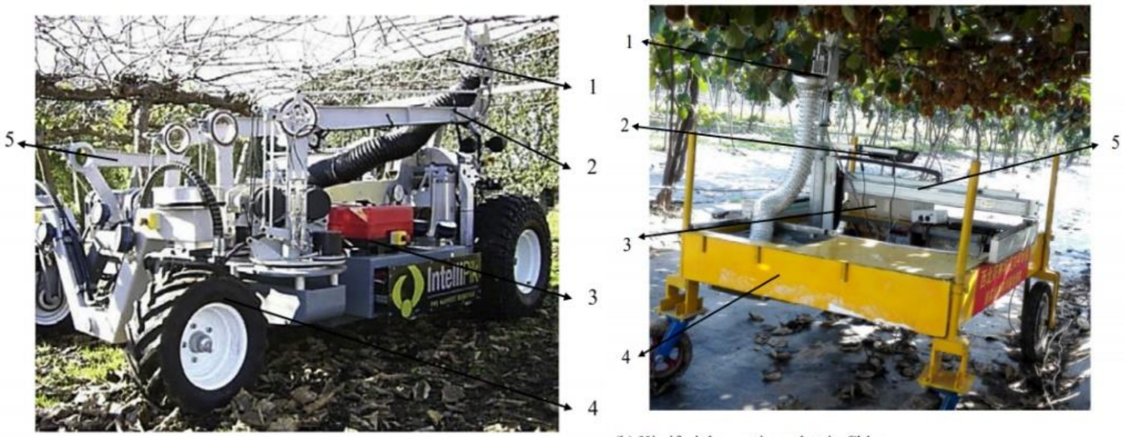
The yield varies a lot (15-35 t ha-1) depending on the year and the orchard. While year-to-year variation is primarily due to environmental conditions (low chilling temperatures, spring frost, windy and wet weather during pollination), orchard-to-orchard variation is primarily related to orchard management. Green fleshed kiwifruit yields in medium and big orchards (near to 35-40 t $ha^{-1)}$. Medium-large orchards start harvesting once the fruit reach at least 6.2 °Brix, although small farmers sometimes harvest earlier regardless of soluble solids content (SSC), particularly in the north, because they fear damage from autumn frosts. New quality controls such as dry-matter content have been introduced by packing-house companies. Harvested fruits are transported to the packing-house, precooled, stored at 0°C and 95% RH for 6-7 months in bulk and graded and packed only when needed for markets (Gallego, 2017).

Postharvest diseases

The main pathogenic fungi are *Botryosphaeria sp*. And *Dhiaporte sp.* Causing ripe rot and stem-end rot, Botrytis rot, Mucor rot, and *Phialophora* rot are considered the main fungal decays of kiwifruit

Alternative technologies for postharvest disease control

Use of synthetic fungicides and appropriate storage technologies to delay the senescence of the fruit. However, rising concerns about fungicide residues and food safety have caused an increase in investigations into non-chemical alternatives to control these diseases



(a) Kiwifruit harvesting robot in New Zealand[4]

(b) Kiwifruit harvesting robot in China
1. End effector; 2. Machine vision; 3. Control box; 4. Vehicle; 5. Mechanical arm

Fig 1. Harvesting machines for kiwifruit

Curing: critical temperatures between 10°C and 20°C and relative humidity higher than 92%. 1 week at 17°C induced wound curing responses in cultivars 'Hayward' and 'Hort16A' kiwifruit, resulting in *Botrytis cinerea* reductions of 4 and 2 fold, respectively, compared to uncured fruit.

Hot water treatment: Dipping kiwifruit in hot water (at 45°C for 10 min) significantly reduced the disease incidence of grey and blue mould.

Biological control agents: Among eco-friendly approaches, BCAs utilizing antagonistic yeasts have been reported as effective tools in postharvest decay control of various fruits for controlling postharvest decay of kiwifruit. Significant reduction of stem-end rot by *B. cinerea* was found in kiwifruit at pedicel wounds treated with the yeast *Aurebasidium pullulans*, artificially inoculated with pathogen conidia suspension and stored under CA for 4 months.

Ozone: Ozone applied in its gaseous form (0.3µl L^{-1}) delayed stem end rot symptoms on kiwifruit in long-term storage by 1 month and reduced by 56% the disease incidence. (Mari *et al.*, 2015).

Kiwifruit exports

Around 40% of world kiwifruit production is exported as fresh fruit, accounting for around 80% of total production outside of China. Exporting countries must meet the criteria and needs of individual importing countries, such as Global Gap.

The proportion of the total exports that are 'Hayward' fruit is likely to increase over the next couple of years as 'Hort16A' continues to be lost to disease and before its replacement, 'Zesy002' (Gold3), comes into full production. Within four to five years, exports of 'Zesy002' fruit are estimated to reach 160,000 t. Of the kiwifruit exported last season, 46% was transported to Europe, 45% to Asia, and 7% to other countries. Chile and New Zealand are direct competitors in that they are both Southern Hemisphere producers. Italy exports much of the kiwifruit it produces, about one-third of the total world trade in kiwifruit (Ferguson *et al.*, 2014).

Conclusion

Hitech cultivation of kiwifruit uses modern production technologies. Kiwifruit has gained importance in our country and has been assessed as one of the important future commercial fruits.

References

Costa, G., Spinelli, F., Soto, A., Nardozza, S., Asteggiano, L., and Vittone, G. (2010). Use of plant bioregulators in kiwifruit production. In *VII International Symposium on Kiwifruit* 913, 337-344.

Donati, I., Cellini, A., Sangiorgio, D., Caldera, E., Sorrenti, G., and Spinelli, F. (2020). Pathogens associated to kiwifruit vine decline in Italy. *Agriculture*, 10(4), 119.

Erturk, Y., Ercisli, S., Haznedar, A., and Cakmakci, R. (2010). Effects of plant growth promoting rhizobacteria (PGPR) on rooting and root growth of kiwifruit (*Actinidia deliciosa)* stem cuttings. *Biological research*, 43(1), 91-98.

Ferguson, A. R. (2014). Kiwifruit in the world-2014. In *VIII International Symposium on Kiwifruit* 1096, 33-46.

Gallego, P. P. (2017). Kiwifruit production and research in Spain. In *IX International Symposium on Kiwifruit* 1218, 23-30.

Lastuvka, M., Benech-Arnold, R., and Windauer, L. (2021). A stratification thermal time-based model as a tool for designing efficient methodologies to overcome seed dormancy constraints to kiwifruit seedling production. *Scientia Horticulturae*, 277, 109796.

Mari, M., Spadoni, A., and Ceredi, G. (2015). Alternative technologies to control postharvest diseases of kiwifruit. *Stewart Postharvest Review*, 11(4), 1-5.

Mu, L., Liu, H., Cui, Y., Fu, L., and Gejima, Y. (2018). Mechanized technologies for scaffolding cultivation in the kiwifruit industry: A review. *Information Processing in Agriculture*, 5(4), 401-410.

Homolomena aromatica- A COMMERCIALLY EXPLOITED PLANT FROM NATURAL HABITAT

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Abstract

Homolomena aromatica commonly known as Sugandhmantri is a high valued economic plant known for its both medicinal and aromatic character. Found sparsely in the north eastern region of India, the medicinal character was long explored by native people of the region. However, its essential oil has got immense economic value in both domestic and international market. Like other medicinal plants of India, this crop has also faced threat of excessive and indiscriminate collection from the wild. Hence, it requires awareness among the farmers about the economic potential and development of scientific production techniques for better production results.

Keywords: Sugandhmantri, Medicinal plants, Homolomena aromatica, Essential oil, North East India.

Introduction

India is bestowed with four biodiversity hotspot with around 9500 species of plants having ethnobotanical importance and around 8000 species of plants having medicinal uses in both traditional and modern systems. Among these species, Homolomena aromatica is one such species which is a high valued medicinal and aromatic plant used for both traditional and modern methods of treatments for various ailments like rheumatoid Arthritis, skin diseases, deafness and many more. It is a popular traditional medicinal plant among several tribes of South Asian region. There are about 23 species of Homolomena spread across different regions of South Asia (southern Yunnan region of China, North East India, Bangladesh, Laos, northern Myanmar, Vietnam and northern Thailand) out of which 6 species are distributed within Indian and 2 species (*Homolomena aromatica* and H. *rubescens)* are exclusively found in North East Indian region. While H. *aromatica* posses medicinal and aromatic characters, H. r*ubescens* is a popular indoor ornamental plant. The plant is grown in hill slopes and foot hills along with other vegetation where sufficient shade of around 40-45% is available. Every part of the plant from leaves, petiole to rhizomes has got many beneficial uses. The commercially most important part can be identified as the rhizomes which has got both medicinal and aromatic properties. The medicinal properties include antidepressant, antiseptic, analgesic, sedative, antispasmodic, anti-inflamatory and skin infections. Moreover, the essential oil from the rhizomes has a high demand in perfumery and cosmetic industries. Due to its camphor like smell from the rhizomes, it is popularly named as *Sugandhmantri* in the market. However, this crop is known by different local names such as *Gonsona* in Assamese, *Gandhikochu* or *Gandhakochu* in Bengalee, Aancheri in Mizo, *Hongu-kakla-manbi* in Manipuri.

Botany

It is a terrestial evergreen plant belongs to the family Araceae. It grows upto a height of 30-60 cm with short and erect stems of around 1-3 cm in diameter. It bears cordate or saggitate leaves of around 20-35 cm long and 15-25 cm broad with long petioles and the presence of sheath below. The leaves arise from the underground rhizomes which are covered with scales and adventitous roots and emits camphor like smell. The plant grows in clumps and bears small flowers which are generally unisexual and enclosed within a spathe. The flowering takes place during May-August.

Cultivation

Growing conditions: H. aromatica is a shade loving plant which requires around 40-60% shade. Hence, cultivation can be taken up as intercrops with plantation crops which may provide its required shade. It is also a moisture loving crop which prefers a humid climate with annual rainfall of about 200-300cm. With proper shade and moisture, the plant shows more height and increase yield of rhizome. Water stagnation for some period was found beneficial for rhizome elongation. The preferable soil type is sandy to sandy loam with slightly acidic condition of ph 4.9- 5.5.

Propagation and planting: Propagation is mainly done through rhizomes of around 2.5-3 cm in diameter with active buds. The germination of seed is very poor. Tissue culture may be a more commercially feasible method for propagation. In-vitro propagation using rhizome bud explants was successful in H. *aromatica.* The planting is done in ridge and furrow method where already sprouted rhizomes are placed in the furrows. The furrows are made at 30 cm apart while rhizomes are placed at 45 cm spacing within a furrow. It takes around 30 days for fresh rhizomes to start sprouting. The best planting time is during pre-monsoon and monsoon period.

Nutrient management: The plant requires a good amount of organic matter for its growth. However, application of external fertiliser at the rate of 40:50:60 kg N:P:K per hectare per year can be applied. The fertilisation should be done during pre monsoon period.

Disease and pest: No major pest has been reported till now. However, collar rot disease caused by *Sclerotium delphinii* in West Tripura has been reported recently.

Harvesting ad post-harvest processing: The rhizome gets ready in 3 years to harvest. Harvesting should be done during the winter period when oil accumulation is more in the rhizomes. Side rhizomes should be left in the soil for ratoon crop. After harvesting, the leaf sheaths and roots are removed and the rhizomes are cut into pieces of 2.5-3 cm for drying. Initial drying upto 50 % moisture should be done on oven. Further drying in sun should continue until it reaches the optimum point which can be judged when rhizomes become hard to produce a rattling sound. During distillation for essential oil, maximum recovery of 1 percent can be achieved.

Uses

1. **As vegetable**: Some tribes of North East India consume the leaves and rhizomes as vegetables. The petioles are used as condiment in curry for its pleasant scent.

2. **Traditional medicine**: Paste and concoctions from the leaves and rhizomes are traditionally used in treating different ailments like rheumatics, stomach ache, injuries and fractures etc.

3. **In industries**: The essential oil from the rhizomes are used mainly in the perfumery and cosmetic industry. The spent out product after distillation is used in production of incense sticks.
4. **Antiseptic use**: Anti fungal properties against dermatophytes and yeasts has been reported which suggests the use of essential oil against skin infections.
5. **Larvicidal and repellent properties**: The rhizome is found to have larvicidal properties against mosquitoes and repellent properties against termites and black flies.
6. **High antioxidant activity** was detected from root extract of *H. Aromatica.*

Table 1.: Ethnomedicinal uses of *H. aromatica*

Sl. No	Plant parts	Traditional use
1	Leaves and rhizomes	Skin infections, common cold in women, jaundice, diarrhoea
2	Petiole	Condiment
3	Rhizomes	Injuries, fractures, intestinal parasites, liver and kidney problems, anti-inflammatory agent, asthama, mosquito repellant

Marketing

The primary raw product marketed is the rhizomes. Mostly, rhizomes are collected from the wild habitat. The final product which is the essential oil is sold for around Rs. 30000-40000 per kg whereas the farmers receive a meagre amount for the rhizomes. Due to lack of awareness among the tribes about its value, the middle men takes advantage by collecting the rhizomes for only Rs 1 -2 per kg of fresh rhizomes. However, some nurseries and factories at Assam are providing Rs. 60-90 per kg of dried rhizome to the farmers.

Way forward

1. The crop has been spread in vast area of the hill slopes and foot hills of the north eastern part of India but due to excessive and indiscriminate collection from the wild without increasing the plantation area, it has become endangered. Hence proper awareness about its economic value should be made among the farmers along with encouragement for its systematic cultivation.
2. Although, the crop has been associated with different traditional medicines against several diseases but they lack scientific establishment. Hence, more research should be taken up for
3. Development of proper package of practices for better production and to reduce the long gestation period is required along with sustainable and quick methods of propagation is necessary.

Hence, *H. aromatica* is a high value crop which can be explored to uplift the rural economy for which interventions from different communities such as scientific, farming, trading and manufacturing communities should come together.

References:

Debbarma, R., Rout, S., Khare, N., & Panigrahi, S.(2021). Indegenous species Homalomena aromatica Schoott of Tripura, India.*International Research Journal,* 2, 101-102.

Goswami, A.K., Banu, Z.W., Sharma, H.K.(2016).CNS effect of Homolomena aromatica based on linalool content: A review. *Current trends in Pharmaceutical Research,* 3(2), 20-38.

Kamil, D., Bahadur, A., Debnath, P., Choudhary, S.P., Kumari, A., & Das, A.(2023). A report of collar rot disease of Sugandh mantri (Homalomena aromatica) caused by *Sclerotium delphinii* in West Tripura state of India. *Crop Protection,* 168.

Khan, T.U., Hore, D.K., & Borthakur, S.K.(2010).Sugandhmantri [Homalomena aromatica Schott]: a potential aromatic and medicinal plant of North East India. *Pleione**,** 4(1): 1 - 3.*

Kehie, M., Kehie, P., Pfoze, N.L.(2017). Phytochemical and ethnopharmacological overview of endangered Homalomena aromatica Schott: An aromatic medicinal herb of Northeast India. *Indian Journal of Natural Products and Resources,* 8(1),18-31.

Mishra, S.K., & Shankar, R.(2020). Exploration and conservation of Sugandhmatri(Homolomena aromatica (Spreng.) Schott.): A valuable medicinal plant of North East India. *World Journal of Pharmacy and Pharmaceutical Sciences,* 9(9),2011-2020.

North Eastren Council. Package of practice:Sugandhmantri cultivation. In Advancing North East (1-8), North Eastern Council.

Sahu, A., & Sahu, N.(2015). Sugandhmatri: The wonder plant at a glance. In Manjari, NTFP centre of Excellence, Tripura.

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OPTIMIZING MEDICINAL CROP SEED QUALITY THROUGH PRIMING TECHNIQUE

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Introduction:

At the present time, the importance of medicinal plants has escalated significantly due to their valuable disease-fighting properties, characterised by their minimal side effects. Consequently, the cultivation of medicinal crops has become a necessity, serving to fulfil the growing demand and preserve their genetic diversity for future requirements. Profound knowledge of propagating materials is essential for the successful cultivation of any crop. Given the limited availability of planting materials, there is now a strong focus on the propagation of medicinal crops through the use of seeds. However, medicinal crops present specific challenges in terms of germination, highlighting the necessity for standardised germination test criteria, particularly concerning factors like temperature and substrate. These variables have a significant impact on both the speed and the ultimate percentage of germination. In medicinal and aromatic crop cultivation, the germination of seeds and the successful establishment of seedlings in the field can frequently prove to be challenging. A straightforward approach to boost seed germination, promote seedling establishment, and thereby enhance the overall field performance of medicinal plants is through the utilisation of various techniques aimed at improving seed quality (Patel and Gupta, 2000). The quality of the seeds used plays a crucial role in determining the efficiency and effectiveness of all other inputs in the production technology. This significance of using high-quality seeds to increase crop productivity has been consistently emphasised throughout history, as evident in ancient testimonials, literature, scriptures, treatises, epics, and numerous other ancient documents.

Over the years, extensive critical observations and elaborate experiments conducted across continents have revealed various methods to boost the vigour of germinating seedlings as they emerge from the seed. These methods result in a uniform crop stand and ultimately lead to significantly higher yields. These straightforward techniques include seed priming, seed pelleting, and seed coating. In modern agriculture, nanoparticles are also employed to improve various aspects, such as delivering nutrients directly to germinating embryos or preventing seed-borne pathogens from entering through cell membrane pores. This approach aims to achieve higher productivity by promoting the growth of robust and healthy crops. The primary focus of this article has been on the examination and exploration of significant seed enhancement techniques, along with highlighting successful case studies within the realm of medicinal crops.

Influence of techniques to improve seed quality on the germination, development, and yield of medicinal crops:

Seed quality enhancement techniques are employed with the goal of improving seed quality parameters, such as enhancing seed germination rates and increasing seedling vigour. These methods also aim to mitigate or reduce the negative impacts of environmental stressors. There is substantial evidence to support the idea that seed priming, which involves treating seeds with specific chemicals or organic substances and subjecting them to various soaking treatments, has successfully invigorated numerous crops. The application of various coatings to seeds, including insecticides and nutrient coatings, has been shown to promote uniform seed germination and the development of consistent crop stands in many agricultural crops. This ultimately results in increased productivity, along with favourable seed quality characteristics.

Seed priming:

Seed priming involves carefully hydrating seeds to a specific level that allows for pre-germination metabolic activities to take place while still preventing the actual emergence of the radicle. Under optimal conditions during seed germination, the uptake of water by dry seeds can generally be categorised into three phases. Phase I involves rapid imbibition, primarily due to the matric forces exerted by the seed. This initial phase occurs in both dormant and non-dormant seeds, whether they are viable or non-viable. During this initial phase, DNA and mitochondria undergo repair, and proteins are synthesised using pre-existing messenger ribonucleic acid (mRNA). Phase II, known as the lag phase or activation phase, is characterized by minimal net water uptake but significant metabolic activities that prime viable, non-dormant seeds for the emergence of the radicle. During this phase, the synthesis of new mitochondria and proteins takes place through the utilisation of newly formed mRNA. During Phase III, which can be considered the final phase, there is a notable increase in water uptake, and this coincides with the elongation of the radicle (Bewley and Black, 1994; Bradford, 2017). Among several techniques, seed priming is a distinct method used for invigorating germinating seedlings. Depending on the substances used for seed hydration, various forms of seed priming can be employed, including hydro priming, chemical priming (treatment of KNO_3, GA_3), halo priming (using a salt solution, such as NaCl), osmo priming (involving an osmotic solution, typically PEG), and sand matric priming (involving moist sand).

Advantages of seed priming:

Seed priming brings various advantages, such as;

- Boosting germination percentages
- Improving the speed and uniformity of germination
- Increasing resistance to water and temperature stress
- Extending seed shelf life
- Particularly suitable for small seeds, and ultimately leading to enhanced crop yields.

Seed priming and its field performance:

Seed quality improvement methods are engaged to expedite emergence, achieve uniformity in emergence, and enhance allometric changes in various medicinal, horticultural, and field crops. As per Tzortzakis in 2009, pre-sowing treatments were observed to boost the fresh weight of seedlings in both endive (*Cichorium endivia*) and chicory (*Cichorium intybus*). It was noted that the application of water and potassium nitrate (at a concentration of 1%) as seed priming agents led to enhanced emergence percentages and the initial establishment of seedlings in the field. Ghassemi-Golezani *et al.* (2012) reported that treating seeds with NaCl can be utilised to increase the grain yield of isabgol (*Plantago ovata* Forsk), leading to a subsequent enhancement in mucilage production. Moreover, it has been observed that seeds invigorated with KNO_3 and GA_3 result in an improved essential oil percentage in fennel (Hoseini *et al*., 2013). The quick emergence of seedlings has the potential to result in the development of robust plants. Pre-sowing seed management techniques offer advantages such as invigoration, protection, and enhanced production. Seed treatment involves enhancing seed performance, leading to superior field performance compared to untreated seeds. The successful establishment of seedlings in the soil is a crucial and fundamental requirement for achieving better crop production. Furthermore, enhancing the percentage of seedling emergence can contribute to establishing the ideal plant population density across a diverse range of environmental conditions.

Chemical priming:

Seed priming using various chemicals, including KNO_3, selenium, butenolide, $ZnSO_4$, paclobutrazol, $CuSO_4$, KH_2PO_4, ethanol, putrescine, chitosan, and choline, resulted in a significant enhancement of seed vigour in the presence of salinity stress (Jaleel *et al.*, 2007; Khaliq *et al.*, 2015). Sarwar *et al.* (2006) found that the application of KNO_3 (0.5%) and K_2HPO_4 (0.5%) in seed priming had a substantial and beneficial effect on seedling growth in a saline environment. Sowmya *et al.* (2012) findings indicate that the dormancy in *Withania somnifera* seeds can be successfully overcome by utilising GA_3 treatment within the concentration range of 500-1000 ppm. According to Su *et al.* (2006), seeds exposed to choline treatment showed improved performance in the presence of salinity stress, primarily attributed to the higher accumulation of *glycine betaine*. Arnab *et al.* (2008) revealed that gibberellic acid (GA_3) exhibited a promising potential for breaking seed dormancy, leading to accelerated seed germination rates in isabgol (*Plantago indica*). Sadeghi and Robati (2015) found the most favourable germination percentage and primary seedling growth outcomes were observed in the ascorbic acid priming treatment, closely followed by the KCl treatment.
Hedychium spicatum seeds treated with gibberellic acid (GA_3) and potassium nitrate (KNO_3) emerged as notably successful approaches to promoting the germination of this plant species (Giri and Tamta, 2012).

Conclusion:

The application of seed quality enhancement techniques plays a crucial role in improving the quality of medicinal and aromatic crops before planting. However, there is a lack of comprehensive information on seed invigoration techniques specific to these crops. Therefore, it is imperative to investigate the potential of such methods that can ensure the successful emergence and early development of seedlings in medicinal crop cultivation. Among the various seed quality enhancement techniques, chemical priming stands out as a popular and commercially adopted method designed primarily to expedite the germination process and helps to break the dormancy, both in favourable and unfavourable conditions. Thus, it represents an effective solution for crops facing germination-related challenges.

Potassium nitrate treatment to Isabgol seeds

Potassium nitrate treatment to Chandrashoor seeds

References:

Arnab, G., Parihar, S. S., Choudhary, V. K., Naseem, M., & Maiti, R. K. (2008). Germination, dormancy and its removal in isabgol (Plantago ovata Forsk). *International Journal of Agriculture Environment & Biotechnology*, 1(3), 117-124.

Bewley, J. D., Black, M., Bewley, J. D., & Black, M. (1994). Cellular events during germination and seedling growth. Seeds: physiology of development and germination, (pp. 147-197).

Bradford, K. J. (2017). Water relations in seed germination. In Seed development and germination (pp. 351-396). Routledge.

Ghassemi-Golezania, K., Zafarani-Moattara, P., & Chadordooz-Jeddia, A. (2012). Improving isabgol (Plantago ovata forsk) performance under salinity by seed priming. *International Journal of Plant, Animal and Environmental Sciences*, 2, 16-21.

Giri, D., & Tamta, S. (2012). Effect of pre-sowing treatments on seed germination in Hedychium spicatum: An important vulnerable medicinal plant of Indian Himalayan region. *Scientific Research and Essays*, 7(19), 1835-1839.

Hoseini, M., Rahimzadeh-Khoei, F., & Mirshekari, B. (2013). Seed priming techniques improve germination and yield in two landraces of lemon balm in laboratory experiment and field study. *Internat J Indigenous Med Plants*, 29(1), 1144-1150.

Jaleel, C. A., Gopi, R., Manivannan, P., & Panneerselvam, R. (2007). Responses of antioxidant defense system of Catharanthus roseus (L.) G. Don. to paclobutrazol treatment under salinity. Acta Physiologiae Plantarum, 29, 205-209.

Khaliq, A., Aslam, F., Matloob, A., Hussain, S., Geng, M., Wahid, A., & ur Rehman, H. (2015). Seed priming with selenium: consequences for emergence, seedling growth, and biochemical attributes of rice. *Biological trace element research*, 166, 236-244.

Patel, M., Gupta, A., & India, I. (2000). Seed Enhancements: The Next Frontier.

Sadeghi, H., & Robati, Z. (2015). Response of Cichorium intybus L. to eight seed priming methods under osmotic stress conditions. Biocatalysis and Agricultural Biotechnology, 4(4), 443-448.

Sarwar, N., Yousaf, S., & Jamil, F. F. (2006). Induction of salt tolerance in chickpea by using simple and safe chemicals. Pakistan Journal of Botany, 38(2), 325.

Sowmya, K. J., Gowda, R., Bhanuprakash, K., & Yogeesha, H. S. (2012). Standardization of seed testing and storability in ashwagandha (withania somnifera). Quality seeds and planting material in Horticultural crops, (pp. 441).

Su, J., Hirji, R., Zhang, L., He, C., Selvaraj, G., & Wu, R. (2006). Evaluation of the stress-inducible production of choline oxidase in transgenic rice as a strategy for producing the stress-protectant glycine betaine. *Journal of Experimental Botany*, 57(5), 1129-1135.

Tzortzakis, G. N. (2009). Effect of pre-sowing treatment on seed germination and seedling vigour in endive and chicory. *Horticultural Science*, 36(3), 117-125.

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PICKERING EMULSIONS: A COMPREHENSIVE INSIGHT OF FUNDAMENTALS AND MECHANISMS

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Abstract:

Pickering emulsions, shedding light on the versatile and intriguing interfacial phenomena that govern their stability and behaviour. Pickering emulsions, stabilized by solid colloidal particles at the oil-water interface, have gained significant attention due to their relevance in various industries, from food and cosmetics to pharmaceuticals and environmental remediation. Substituting solid particles for traditional surfactants, Pickering emulsions are more stable against coalescence and can obtain many useful properties. As the interest in sustainable and surfactant-free emulsions continues to grow, this article provides a valuable resource for researchers and practitioners alike. The article delves into the key principles of Pickering stabilization, morphology of solid particles, and its applications in different fields.

Keywords: Pickering emulsion, solid particle, colloidal particles

Introduction:

Emulsions, colloidal suspensions of two immiscible liquids, have played a pivotal role in a multitude of industries for generations. Whether it's the creamy texture of mayonnaise, the stability of pharmaceutical formulations, or the enhanced oil recovery in the petroleum industry, emulsions play a vital role. Traditional emulsions rely on surfactants or emulsifying agents to stabilize the interface between the two immiscible phases (Yang *et al*., 2017). However, in recent years, a ground-breaking alternative has emerged: Pickering emulsions. Named after the British chemist Percival John Pickering, these emulsions are characterized by their unique stabilization mechanism—solid particles at the oil-water interface. This innovative approach has sparked significant interest across industries, from food and cosmetics to pharmaceuticals and materials science (Silva *et al*., 2021).

Classification of emulsion

Emulsions are colloidal systems consisting of two immiscible liquids, typically oil and water, stabilized by an emulsifying agent or surfactant. Emulsions can take various forms depending on the ratio of the two phases and the nature of the emulsifying agent. Here are the main types of emulsions:

1. **Oil-in-Water (O/W) Emulsion:** Tiny droplets of oil are dispersed within a continuous phase of water. The emulsifying agent surrounds the oil droplets, preventing them from coalescing. Examples: milk, vinaigrette salad dressing, cosmetic creams, and lotions.

2. **Water-in-Oil (W/O) Emulsion**: Small droplets of water are dispersed within a continuous phase of oil. The emulsifying agent forms a protective layer around the water droplets to keep them from merging. Examples: butter, margarine, and certain types of cold creams.

3. **Multiple Emulsion (W/O/W or O/W/O)**: Multiple emulsions are nested emulsions within each other. For example, in a water-in-oil-in-water (W/O/W) emulsion, water droplets are dispersed in an oil phase, which is then dispersed in a continuous water phase. Multiple emulsions are used in controlled-release drug delivery systems and complex food products.

4. **Microemulsion:** Thermodynamically stable, transparent, and optically isotropic emulsions. They have very small droplet sizes and are typically composed of water, oil, surfactant, and co-surfactant. Commonly used in pharmaceuticals, cosmetics and chemical process.

5. **Pickering Emulsion:** Pickering emulsions are stabilized by solid particles adsorbed at the oil-water interface. These solid particles prevent coalescence of the dispersed phase. Pickering emulsions have applications in food, cosmetics, and materials science.

   Pickering emulsions can be classified based on the nature of the dispersed and continuous phases. The choice of solid particles and their concentration can influence whether an O/W or W/O Pickering emulsion is formed. There are two primary types:

   - **Oil-in-Water (O/W) Pickering Emulsion:** In this type of emulsion, tiny oil droplets are dispersed within a continuous water phase. It is commonly used in food and cosmetic industries to stabilize oil-based products, such as salad dressings and creams.
   - **Water-in-Oil (W/O) Pickering Emulsion:** In W/O Pickering emulsions, small water droplets are dispersed in a continuous oil phase. This configuration is utilized in various applications, including pharmaceuticals, enhanced oil recovery, and materials science.

6. **High Internal Phase Emulsion (HIPE):** HIPEs are emulsions where the dispersed phase (typically oil) comprises a large fraction of the total volume, often exceeding 74%. These emulsions are highly viscous and have applications in the production of porous materials like foams and scaffolds.

7. **Inverse Emulsion:** The phase that is usually the continuous phase becomes the dispersed phase, and vice versa. These emulsions are less common and can be used in specific industrial processes.

8. **Latex Emulsion:** It consist of finely dispersed polymer particles in water. They are used in the production of paints, coatings, adhesives, and synthetic rubber.

9. **Bitumen Emulsion:** It is the mixtures of bitumen (asphalt) and water, stabilized by emulsifying agents. They are commonly used in road construction and maintenance for applications like road sealing and pavement recycling.

10. **Solid-in-Oil (S/O) and Solid-in-Water (S/W) Suspensions:** While not traditional emulsions, these systems involve the dispersion of solid particles in either an oil or water phase, often stabilized by surfactants. These suspensions are used in various industries, including pharmaceuticals, paints, and cosmetics.

Pickering emulsion

Pickering emulsion is a type of emulsion stabilized by solid particles instead of traditional surfactants (Zhang *et al*., 2022). These solid particles adsorb at the oil-water interface, creating a protective barrier that prevents the coalescence of the dispersed phase (either oil-in-water or water-in-oil) (**Fig. 1)**. This unique stabilization mechanism has garnered significant interest in various industries due to its stability, versatility, and potential applications.

The type of Pickering emulsion, whether oil-in-water (O/W) or water-in-oil (W/O), depends on how well solid particles are wetted at the oil-water interface. When one liquid wets the particles more than the other, it becomes the continuous phase, while the less wetting liquid becomes the dispersed phase. O/W emulsions occur when the contact angle θ (at the boundary of solid particles, continuous phase, and dispersed phase) is less than 90º (e.g., silica, clay), while W/O emulsions form when θ is greater than 90º (e.g., carbon black). Effective Pickering stabilization by particles typically occurs when θ is close to 90º. If particles are too hydrophilic (resulting in a low θ) or too hydrophobic (resulting in a high θ), they tend to remain dispersed in either phase (Yang *et al*., 2017).

In this article, various kinds of commonly used solid particles, morphology of solid particles being used and materials being fabricated, as well as applications and limitations of Pickering emulsions.

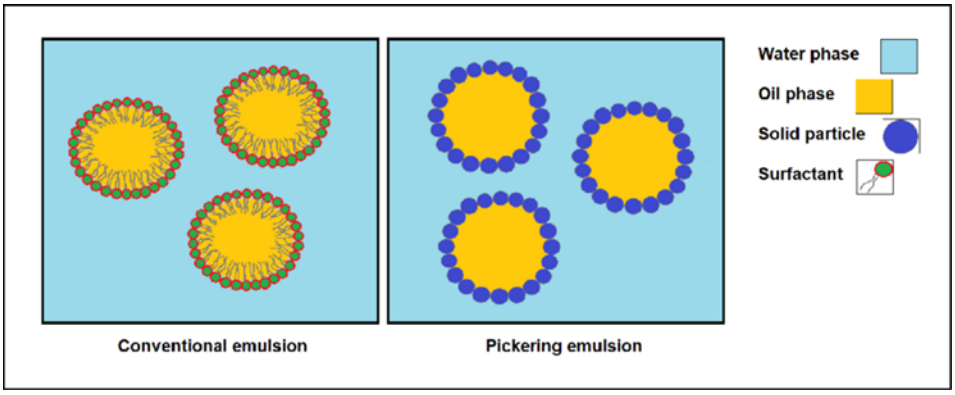

Fig.1: Schematic view of conventional and Pickering emulsion *(Hui et al., 2022)****.***

Morphology:

The morphology of Pickering emulsions can vary depending on several factors, including particle size, shape, and concentration:

- ✓ **Regular Emulsion:** Uniformly dispersed droplets with a stable interface.
- ✓ **Multiple Emulsions:** Emulsions within emulsions (e.g., water-in-oil-in-water) can be formed.

- ✓ **Gel-like Structures:** High particle concentrations can lead to gel-like structures with trapped droplets.
- ✓ **Janus Particles:** Particles with two distinct surface properties, like hydrophobic and hydrophilic sides, can induce asymmetry in emulsion droplets.

Solid Particle Materials

At the heart of Pickering emulsion are solid particles, which serve as the stabilizing agents at the interface between the two immiscible phases. The choice of solid particles is critical and depends on the specific application. Commonly used solid particle materials include:

1. **Inorganic Particles:** Silica nanoparticles, clay minerals like montmorillonite, titanium dioxide, and calcium carbonate are frequently employed for their stability and ease of functionalization.

2. **Organic Particles:** Organic particles, such as cellulose nanocrystals, chitosan particles, and various polymer particles, offer a biocompatible and tuneable alternative.

The properties of these particles, including size, shape, and surface chemistry, can significantly impact the stability and behaviour of Pickering emulsions.

Emulsifiers derived from natural sources:

Food-grade Pickering emulsifier mainly includes inorganic particles includes: protein, polysaccharide, and lipid emulsifiers are specific types of emulsifiers or surface-active agents derived from natural sources. They have unique properties and are commonly used in various applications, including food, pharmaceuticals, cosmetics, and biotechnology (Lu *et al.*, 2021).

1. Protein Emulsifiers:

Protein emulsifiers are emulsifiers derived from proteins, which are large biomolecules composed of amino acids. These emulsifiers are often found in foods and are used for their emulsifying, foaming, and stabilizing properties. Such as **lecithin, gluten, zein, casein, soya protein,** and **whey Proteins.**

2. Polysaccharide Emulsifiers:

Polysaccharide emulsifiers are derived from polysaccharides, which are complex carbohydrates composed of sugar units. These emulsifiers are known for their thickening and stabilizing properties. Common polysaccharide surfactants include **gum arabic, modified starch particles, microcrystalline cellulose, xanthan gum,** and p**ectin.**

3. Lipid Emulsifiers:

Lipid emulsifiers, also known as amphiphilic lipids, are naturally occurring lipids or lipid-derived molecules that have both hydrophilic (water-attracting) and hydrophobic (water-repelling) regions. They are often used as emulsifiers in pharmaceuticals, cosmetics, and food products. Common lipid surfactants include **phospholipids, mono- and diglycerides,** and **fatty acid esters.**

Applications:

- **Food and Beverage Industry:** Pickering emulsions can be used to stabilize products like salad dressings, mayonnaise, and cream-based sauces, providing improved stability and reduced reliance on traditional emulsifiers. Their natural and clean-label properties are particularly appealing.
- **Pharmaceuticals:** They are employed in drug delivery systems, enabling controlled release of active ingredients and enhancing drug stability.
- **Cosmetics:** Pickering emulsions can be used in skincare and cosmetic products, offering stable and natural formulations and the ability to deliver active ingredients effectively.
- **Oil and Gas Industry:** They have applications in enhanced oil recovery and as drilling fluids, where stability under extreme conditions is crucial.
- **Materials Science:** Pickering emulsions have enabled the creation of novel materials with unique properties, such as foams, films, and aerogels, with tailored properties.
- **Environmental Remediation:** They can be employed for the encapsulation and controlled release of substances in environmental applications, such as the remediation of contaminated sites.
- **Biotechnology:** Pickering emulsions are valuable in bio-catalysis, enzyme immobilization, and bioremediation processes, enhancing the efficiency of various biotechnological processes.

Limitations:

- **Limited Solubility:** Some solid particles used in Pickering emulsions may have limited solubility in the continuous phase, which can affect the stability of the emulsion.
- **Particle Aggregation:** Aggregation of solid particles at high concentrations can lead to phase separation and instability of the emulsion.
- **Rheological Properties:** The presence of solid particles can influence the rheological behavior of the emulsion, making it more viscous or gel-like, which may not be suitable for all applications.
- **Particle Size and Distribution:** Achieving uniform particle size and distribution can be challenging, affecting the consistency of Pickering emulsions.
- **Compatibility:** Compatibility issues may arise when formulating Pickering emulsions with certain ingredients, especially in complex matrices like food products or pharmaceuticals.
- **Limited Shelf Life:** The stability of Pickering emulsions may deteriorate over time, especially in storage conditions that promote particle settling or aggregation.

Conclusion:

In the world of emulsions, Pickering emulsions stand as a remarkable innovation, challenging the conventional wisdom of emulsion stabilization. By harnessing the affinity of solid particles for both oil and water, these emulsions have found their way into numerous industries, offering enhanced stability, improved functionality, and exciting possibilities. Whether it's creating better food products, designing advanced drug delivery systems, or developing novel materials, Pickering emulsions have proven their worth. As researchers continue to uncover new particle materials and explore novel applications, the future of Pickering emulsions appears bright, promising even more ground-breaking advancements in the world of colloidal science.

References:

Lu, Z., Zhou, S., Ye, F., Zhou, G., Gao, R., Qin, D., & Zhao, G. (2021). A novel cholesterol-free mayonnaise made from Pickering emulsion stabilized by apple pomace particles. *Food Chemistry*, *353*. https://doi.org/10.1016/j.foodchem.2021.129418

Shao Hui, T., Chee, C., Fahmi, Z., Sakti, S. C. W., & Lee, H. (2022). Review of Functional Aspects of Nanocellulose-Based Pickering Emulsifier for Non-Toxic Application and Its Colloid Stabilization Mechanism. *Molecules*, *27*, 7170. https://doi.org/10.3390/molecules27217170

Silva, T. J., Barrera-Arellano, D., & Ribeiro, A. P. B. (2021). Oleogel-based emulsions: Concepts, structuring agents, and applications in food. *Journal of Food Science*, *86*(7), 2785–2801. https://doi.org/10.1111/1750-3841.15788

Yang, Y., Fang, Z., Chen, X., Zhang, W., Xie, Y., Chen, Y., Liu, Z., & Yuan, W. (2017). An overview of pickering emulsions: Solid-particle materials, classification, morphology, and applications. In *Frontiers in Pharmacology* (Vol. 8, Issue MAY). Frontiers Research Foundation. https://doi.org/10.3389/fphar.2017.00287

Zhang, S., Geng, S., Shi, Y., Ma, H., & Liu, B. (2022). Fabrication and characterization of Pickering high internal phase emulsions stabilized by Tartary buckwheat bran flour. *Food Chemistry: X*, *16*, 1–7. https://doi.org/10.1016/j.fochx.2022.100513

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ADVANCES IN COCONUT MECHANIZATION

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About article

Coconut is an important plantation crop with a production of 23,800 nuts annually. Mechanization is at peak necessity in the modern farming with prevailing challenges of labour shortage, food security sustainability, human drudgery etc. For mechanizing coconut cultivation, orchard establishment, plant protection, nutrition management, harvesting, logistics, shredding, grading operations were the major scope. Inventions range from manual to robotic machineries, especially harvesters. Innovations and challenges in mechanizing the above cultivational operations were discussed in brief. The article gives an overview of coconut mechanization in the country and suggestions for smart coconut farming.

Introduction

*Cocos nucifera***,** Coconut (archaic "cocoanut") - which is an old Portuguese word in which coco means head or skull. Food and Agriculture Organization stated that by 2050 the world's human inhabitants are expected to reach 9600 crores people. Sustaining the food security to the growing human inhabitants is a challenging task with visible solutions of smart farming. Globally India rank 3rd in the coconut cultivation and major cultivation area prevails in southern parts of India. Various mechanization studies were found on coconut cultivation in the country in different cultivational operations.

Orchard establishment

Establishment involves land preparation, mapping and layout, digging and irrigation installation. Coconut saplings are planted in 3x3x3 ft pit with a spacing of about 20-25 ft. Laser leveller, dozer, front loaders were employed in land preparation practices. Bulldozer with back hoe, tractor operated digger and power auger digger were in use apart from manual digging. Smart innovations such as drone imaging for field mapping and locating plants with desired spacing can be enhanced. With this stage, orchard establishment had become a mechanized operation.

Crop protection

Various kinds of sprayers (power operated), drones were in use for action against pest and diseases. Major pests (red palm weevil, white flies, rhinoceros beetle etc.), diseases (various wilt, bud rot, leaf rot, bleeding etc.) and weeding applied with various sprayers. Canopy spraying is carried out using tall tree sprayers. Recent research interests lies on drone spraying (in-built and spraying arm). Selective action through variable rate technology, John Deere's See and Spray technology, but promises an optimal input use. Machine vision, image processing techniques ease the robotic weeding processes, as invented in various row crops. Practical applications of robotics in orchard weeding are quite simple comparing field crops. Several models of power operated weeders, brush cutters were adoptable and also some were on use.

Nutrition management

Nutrition applications were recommended with root feeding, spraying and basal application in circular basins. Fertigation system, tractor operated basin lister cum fertilizer, sprayers were applicable. Root feeding, especially for coconut tonic is done manually through skilled labours, mechanization is essential in this case. Variable rate fertilizer application technology is recommended. It can be made possible through drone operated multispectral cameras and sampling techniques.

Harvesting

Almost manual skilled labours with sickles were employed in past, but due to the shortage of labours, serious issue arise for harvesting. Shortage of labours is mainly due to the drudgery associated with climbing high trees. Couple of inventions made to solve this issue. Several manual climbing aids, TNAU model, KAU model, chembery model, chocoos maramkeri, kerasuraksha and improved models on this have been developed. Coconut tree hoist for lifting were available at hiring basis in Tamilnadu. Locally made pickers were used for short high trees. Power operated climbers invented by some private companies emerged but challenged by safety issues. Robotic climbers are invented by TNAU, Amrita Vishwa Vidyapeetham (Amaron) and some private industries. They were at research level and not at practical use. Object detection, image processing, machine learning techniques are some of the modern tools used with hardware including microcontrollers, magnum wheels, servo motors, stepper motors etc. TNAU, ICAR-Central Coastal Agricultural Research Institute and Goa University involved in drone based cutting mechanism for coconut harvesting. Also KAU Agricultural Research Station - Mannuthy has developed a cradle to collect coconut at crown itself.

Fig.1 TNAU coconut climber and Amaron Robotic coconut climber

Fig.2 TNAU Coconut hoist and Climbing bike

Logistics

Coconuts harvested will be mostly transported to the drying yards through trucks or tractor trailer. On-field transportation is practiced with walk behind carts. But loading/unloading is done manually. Invent of suitable robotic for loading and counting the coconuts may be highly helpful.

Waste management

Coconut leaf shredders, chippers for coconut husk, briquette making, shell conversion technologies were major scope for processing coconut wastes. Mulching, manuring, charcoal production, activated carbon production, rope making, briquettes etc were the outcomes of the above mentioned technologies.

Special operations

Basin listing practice is done using power tiller mounted implements. Some cases manual labours were still in use which involves a hectic drudgery. Tapping neera/toddy is a tedious process with numerous climbings for period of time. CPCRI, Kasaragod had developed a coconut sap chilling machine, and in advance, Nava Design & Innovation Pvt Ltd invented a Automatic toddy/neera tapping robot named saper based on artificial intelligence and solar energy.

Fig.3 Basin listing and Saper robot

Conclusion

In the view of agriculture 4.0, technology advancements enhancing coconut production hikes and its sustainability suiting the growing global food demands. Mechanization followed by automation, smart farming can bring necessary impact on production, drudgery elimination, farmer friendly systems and quality produce. But comparing with the cereals like crop, coconut is least mechanized, poor adoption, but considerable research inventions. Apart from subsidies and supporting tools, steps to be initiated for development and adoption of such inventions through governmental bodies and NGO

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ALTERNATIVE FRYING METHOD FOR IMPROVING QUALITY OF VEGETABLE AND FRUIT FRIES

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Abstract:

The increasing consumer focus on health has led to a need to reduce oil consumption and unhealthy fats. Despite this, deep-fried foods like potato chips remain popular due to their unique taste and texture. Frying is a complex process involving heat transfer, causing physical and chemical changes in food due to the interaction with oil. The frying process includes primary heating, boiling outward, falling rate period, and bubble endpoint. Conventional frying methods have challenges such as maintaining oil quality and minimizing nutrient loss. Emerging frying technologies offer alternatives: microwave frying reduces oil content and processing time, vacuum frying prevents oxidation, ultrasound-assisted frying enhances heat transfer, air frying uses blowing air, and spray frying reduces oil uptake. These innovations strive to balance taste and health concerns in fried foods.

Introduction:

Now a days the increased awareness among consumers towards food, nutrition, and health has emphasized the need to limit oil consumption, calories originating from fat, and cholesterol. Due to their distinctive flavor-texture combinations, consumers have long coveted deep-fat fried foods including potato chips, French fries, doughnuts, extruded snacks, fish sticks, and traditional fried chicken dishes. In 2000, Americans spent $110 billion on fast foods, with fried foods playing an important role. Americans consume about three hamburgers and four servings of French fries per week (Schlosser, 2001). Quality food ingredients and frying oil are responsible for the quality products and now a days the researchers have also been working to continually enhance frying equipments (Pankaj and Keener 2017). Frying is a complex heat and mass transferring cooking process where physical, chemical, and organoleptic changes take place which is mainly due to the interaction between food and oil. The main reaction responsible for the appealing golden-brown color is maillard reaction that breaks down sugar and proteins with the removal of moisture. This dehydration forms a crust which further limits the oil absorption. The different surfaces of food experiences different frying temperatures with highest temperatures being received by peripheral surfaces while core (rich in water) experiencing around 100 ºC of frying temperatures. The rate of heat transfer is affected by composition of food and its heat and mass transfer properties which include thermal conductivity, diffusivity, density, specific heat etc. Upon heating (frying of food) these characteristics are altered (Mallikarjunan *et al*., 2010).

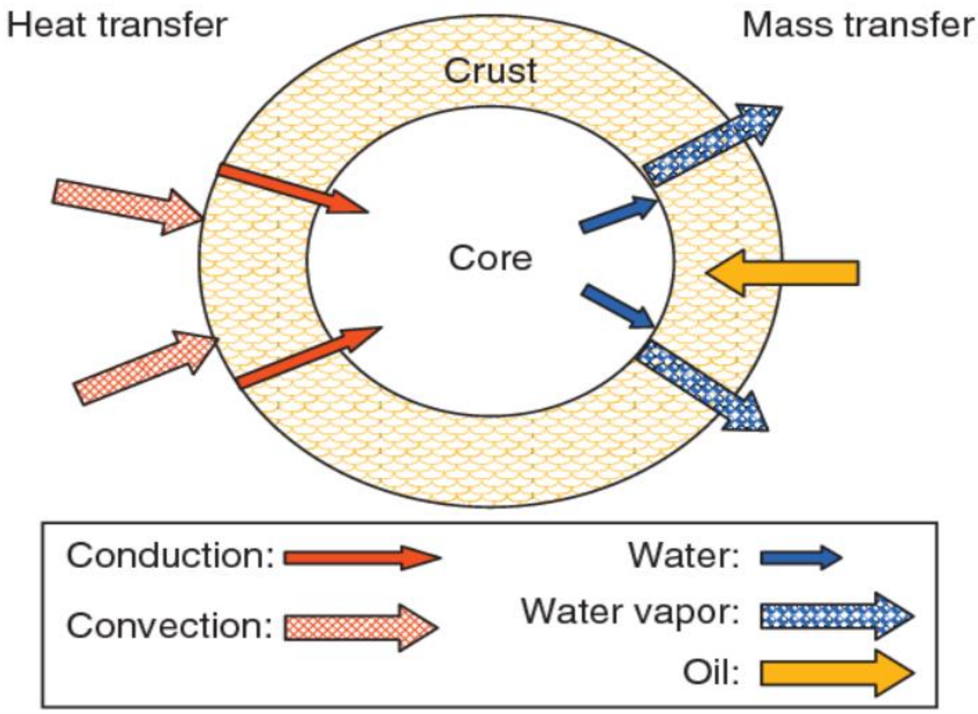

Fig 1: Oil absorption during frying

The whole process of frying can be divided in 4 subgroups:

1. Primary heating: The food is submerged completely in the hot oil till its surface reaches the boiling point of water. There is uniform heating of food surface by convection, but the inner core portion is heated and cooked by conduction where heat diffuses from surface to core.
2. Boiling outward: The water inside the food evaporates due to the presence of hot oil in food surroundings. This in turn circulates the frying oil currents thereby increasing the rate of heat transfer keeping the oil from soaking by crust or surface of food. Cooking oils have thermal conductivity higher than that of air therefore the close contact of hot oil with surface of coating or dough provides rapid heat transfer.
3. Falling rate period: The moisture evaporates continuously and dehydrates the crust; it conducts less heat to the remaining food. The left-over moisture inside the food gets heated slowly to boiling point of water, which cooks the food.
4. Bubble endpoint: This marks the last phase in frying where moisture is no longer evaporating and therefore the food is removed from the oil.

ROLE OF FRYING IN FLAVOR DEVELOPMENT OF THE FRIED FOOD

Food ingredients	**Changes causes during frying**	**References**
Sugar	Pyrolysis (Caramelization) Formation of Maillard products and their thermal decomposition	Ngobese and Workneh (2018)
Amino acid	Direct pyrolysis, deamination Interaction with volatile aldehydes Formation of Maillard products	Santos, Cunha, and Casal (2018
Sulphur compounds	Oxidative pyrolysis and pyrolysis Interaction with aldehydes	Martınez-Yusta *et al.* (2015)
Lipids	Oxidation and cleavage Interaction with amines Interaction with sulphur compounds	Multari *et al.* (2019)
Phenolics	Oxidation Pyrolysis	Sordini *et al.* (2019

Conventional frying methods:

Conventionally adopted frying methods such as deep fat frying, pan frying, and stir frying where food is immersed in edible oil and is heated above the boiling point of water (Moreira, 2014; Shaker, 2015). Higher temperature replaced the water by hot edible oil by converting it into vapour. Due to migration of hot edible oil into the food leads to higher transfer rate and moisture evaporation ultimately resulted into crunchy and crispy texture with better aroma and taste (Moreira, 2014). During the conventional frying, the temperature reaches from 165 to 190 ◦C under atmospheric conditions. At this temperature, rapid physio-chemical changes are occurred with the formation of hard crust, darkening colour and burning aroma even before the food product is completely cooked. Some undesirable changes are chanced during these frying processes which are not often preferred as a healthy consumer's diet (Pankaj & Keener, 2017).

- ➢ The major challenges of conventional frying methods are:
- ✓ Lowering the oil content

- ✓ maintaining the oil quality
- ✓ minimizing the nutrient loss

Alternative new trends in frying technologies:

1. **Microwave frying:**

Microwave is the quickest heating system using electromagnetic waves of range between 300 MHz–300GHz with 1 mm^{-1} m wavelength, (Ghanem *et al*. 2012; Roknul Azam *et al*. 2019).
It is used in many food processing unit operations like drying, pasteurization, baking, sterilization, tempering, blanching, and thawing. MH during frying has the advantage of the quickest heating process which reduces the processing time and also has the advantage of lowing the total oil content in the final fried product (Schiffmann 2017). A comparative study done by Parikh and Takhar 2016 of atmospheric frying and microwave frying of potato chips and French fries and found that microwave heating has given better results in terms of oil uptake and other sensory attributes.

2. **Radiant frying:**

There are three types of heating systems, conduction, convection, and radiation. In the conduction and convection heating system, there should be direct contact between the heating source and heated substance. For the radiant heating systems, exposure of the heat through the substance from an infrared source at the wavelength ranging from 0.78 to 1000 mm. The microwave also uses electromagnetic waves, but the infrared radiant heating system shows more thermal efficiency and responses with much faster heating ability.

3. **Vacuum frying:**

Vacuum frying (VF), also known as pressure frying, where the frying operation is done in a vacuum tank without the presence of air (Fan, Zhang, and Mujumdar 2005). The main advantage of frying in vacuum conditions is that it helps to reduce the boiling point of water and oil, which means we do not need high temperatures like normal atmospheric frying. Moreover, the absence of air during frying helps to stop or reduce the chances of lipid oxidation, acrylamide formation, (Belkova *et al*., 2018) discoloration or reduces the browning reaction and helps to achieve better nutrient retention profile.

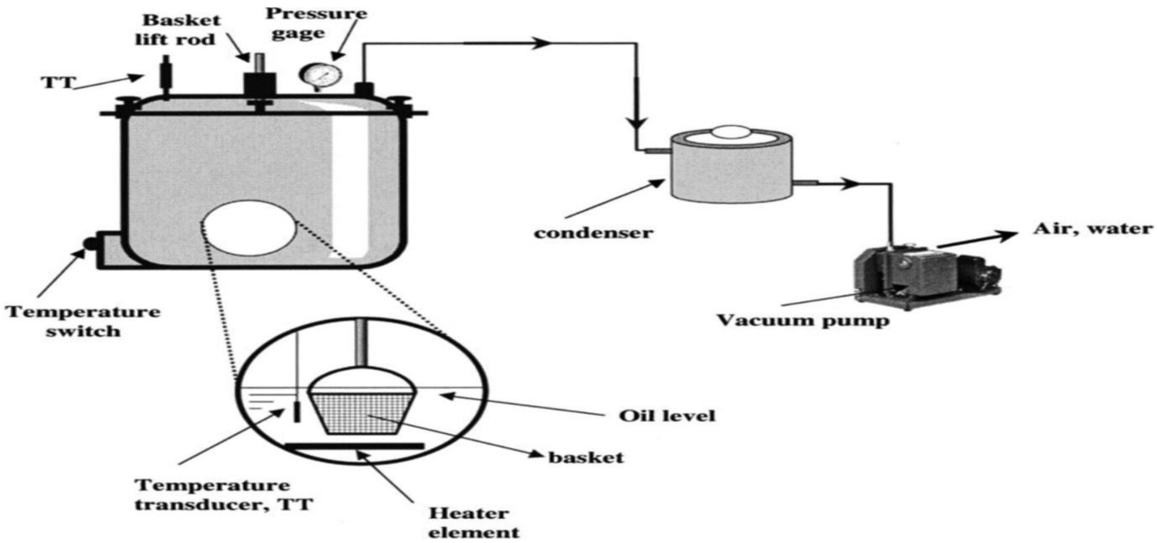

Fig 2: Schematic diagram of vacuum frying equipment

4. **Ultrasound-assisted frying:**

The use of ultrasound during frying helps to increase the heat transfer rate during frying because of micro-vibrational, sponge, and microstreaming effects. On scanning electro-micrograph, it was found that by applying ultrasound during frying the microstructure become more porous, raptured with microscopic holes in some cases. This type of microstructure resulted faster moisture removal rate which tended to make the processing time shorter. Although ultrasound-assisted VF has shown many positive effects in producing a better-quality fried product, it also has a restriction. Ultrasound produces an unbearable amount of sound, which may not be good for health.

5. **Air frying:**

Air frying is a rapid cooking technology of food using a high velocity of blowing air. It is actually an oven designed to solve the slowness of conventional oven by circulating a fan to move the air into the oven (Erickson and Minn 1989). Instead of submerging into the heated oil, in this frying system, the sprinkle of oil applies to the product with air circulation. Tian *et al*. (2017) found from their study that air frying of potato strips showed less than 86% gelatinization, higher than 59% starch digestibility; whereas conventional deep-frying showed 91% gelatinization, and 54% digestibility.

6. **Spray frying:**

Spray frying is another kind of novel frying system where the sample is not placed into the oil rather the heated oil is used to sprayed toward the sample. The efficiency of this frying system depends on the rate of spraying oil. A comparative study of physico-chemical and microstructural properties of fried rice crackers produced by using the spray- and AF techniques was studied by Udomkun, Tangsanthatkun, and Innawong (2020) and revealed that compared to AF, spray-frying resulted in lower oil uptake by 45.4% and better color.

CONCLUSION

Fried products are snacks food that are mainly prepared by snack food industry and the industries are trying to make high-quality fruit and vegetable-based snacks to meet the demand of consumers. For preparing fried food product at industrial and domestic scales, deep frying is most commonly used frying process since long ago. To overcome the limitations of age-old traditional frying methods, vacuum frying has proved to be efficient in reducing quality issue due to frying issue. A novel frying practice could be possible for better quality product development by combining thermal technology (like microwave or radiant) and non-thermal technology (PEF and ultrasound) which is not feasible by traditional frying practices. Further improvement in the quality of product is possible by mingling of techniques like microwave, or radiant energy, using PEF or ultrasound during vacuum frying.

REFERENCES

Devi, S., Zhang, M., Ju, R., and Bhandari, B. (2021). Recent development of innovative methods for efficient frying technology. *Critical Reviews in Food Science and Nutrition*, *61*(22), 3709-3724.

Erickson, C. S., and P. Minn. 1989. Air fryer. Erickson (Ed.).

Fan, L-p, M. Zhang, and A. Mujumdar. 2005. Vacuum frying of carrot chips. Drying Technology 23 (3):645–56. doi: 10.1081/DRT200054159

Khadhraoui, B., Ummat, V., Tiwari, B. K., Fabiano-Tixier, A. S., and Chemat, F. (2021). Review of ultrasound combinations with hybrid and innovative techniques for extraction and processing of food and natural products. *Ultrasonics Sonochemistry*, *76*, 105625.

Quan, X., Zhang, M., Fang, Z., Liu, H., Shen, Q., and Gao, Z. (2016). Low oil French fries produced by combined pre-frying and pulsed-spouted microwave vacuum drying method. *Food and Bioproducts Processing*, *99*, 109-115.

Schiffmann, R. 2017. 7 - Microwave-assisted frying. In The microwave processing of foods, ed. M. Regier, K. Knoerzer, and H. Schubert, 2nd ed., 142–51. Cambridge, UK: Woodhead Publishing.

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REVOLUTIONIZING AGRICULTURE: ROBOTICS AND AUTOMATION IN POSTHARVEST MANAGEMENT

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Abstract

Automation in agriculture is vital for enhancing productivity, improving quality, and driving economic growth. One critical aspect of agricultural automation is fruit grading, which significantly impacts fruit quality assessment and the export market. While humans can perform grading and sorting tasks, it is a slow, labour-intensive, error-prone, and tedious process. Therefore, there is a growing demand for intelligent fruit grading systems. In recent years, researchers have made significant strides in developing algorithms for fruit sorting using computer vision technology. These algorithms primarily rely on colour, texture, and morphology analysis to identify factors such as diseases, fruit maturity, and fruit class. Subsequently, these features are employed to train soft computing techniques.

Keywords: Automation, Robotics, Productivity, Quality and Grading

Introduction

Automation is a technique that can be used to reduce costs and/or to improve quality. Automation can increase manufacturing speed, while reducing cost. It can lead to products having consistent quality, perhaps even consistently good quality. From the initial stages of planting and harvesting to the final steps of distribution and consumption, every facet of agriculture is being redefined. However, it is the remarkable integration of robotics and automation into postharvest management that stands as one of the most promising and transformative developments of our time. The use of robotics in the food industry has increased over recent years, particularly in the field of processing and packaging systems. However, the industry has not taken to the technology with the same enthusiasm as the automotive and other industries. Now days the technology is becoming more affordable and the systems more intelligent, it may be feasible to automate many of the complex and repetitive tasks that are carried out in the food industry (Wallin, 2015). This innovative approach is not merely an incremental change; it represents a seismic shift in the way we approach the handling, processing, and preservation of crops once they have left the field. Its implications are profound, rippling through the entire food supply chain and impacting food quality, safety, and sustainability in ways we could scarcely have imagined.

Need for Automation in Agriculture

To enhance overall operational efficiency and competitiveness, modern businesses are continually seeking ways to optimize their processes and workforce. A key objective is to increase labour productivity, where streamlined workflows, advanced technology, and employee training are leveraged to maximize output per unit of labour. Simultaneously, organizations aim to reduce labour costs by implementing efficient practices, automation, and cost-effective labour management strategies. Worker safety is another paramount concern, and companies invest in safety protocols, training, and equipment to safeguard their employees. These safety measures not only protect workers but also contribute to improved productivity and morale. Quality control is vital for maintaining customer satisfaction and loyalty. By focusing on product quality through rigorous quality assurance processes and technology-driven inspections, organizations can meet or exceed customer expectations. In the face of labour shortages, businesses seek to mitigate their effects by adopting automation and innovative labour management solutions, ensuring uninterrupted operations.

The automation of routine manual and clerical tasks not only reduces errors but also frees up human resources for more strategic and creative endeavours. Manufacturing lead times are reduced through efficient supply chain management, inventory optimization, and process automation, allowing companies to respond more swiftly to customer demands. Certain processes are simply beyond manual capabilities, necessitating automation and advanced technologies for their execution. This enables businesses to achieve tasks that were previously unattainable. Lastly, uniformity in processes and products is ensured through automation and standardized procedures, guaranteeing consistent quality and reliability.

The Role of Robotics and Automation:

1. **Harvesting Efficiency**: The use of robots for harvesting has gained significant attention. These machines are equipped with advanced sensors and computer vision systems that can identify ripe produce, pick it gently, and even sort it according to size and quality. This not only reduces labour costs but also ensures that crops are harvested at their peak freshness.

2. **Sorting and Grading**: Sorting and grading are essential steps in postharvest management to separate high-quality produce from defective or lower-grade items. Automated sorting systems can accurately assess factors like colour, size, and ripeness, ensuring that only the best products reach consumers. Computer vision system can simulate human vision to perceive the three-dimensional feature of spatial objects and has partial function of human brain.

Detection of the Fruit Size: the average consistency between computer vision grading and manual grading is over 93% in terms of obtained feature parameters and the fruit shape analysis technology

Detection of the Fruit Colour: Many special colour models had been set up in some relevant studies. RGB and HIS model were often used in computer vision system to describe colour, which is more similar to the manner of human vision. The HIS model includes three elements: hue, saturation and intensity. Tomatoes were classified into six maturity stages by computer vision system according to the USDA standard classification: Green, Breakers, Turning, Pink, Light Red, and Red

Detection of the Fruit Bruise and Defects on Its Surface: There was a colour difference in the joint region of the defective and non-defective regions of Huanghua pear. The light values of R (red) and G (green) were used to distinguish the defective region from the non-defective region. The whole defective region was found by means of region growing method. Finally, the area of the defective region was calculated. The automatic detecting of pear bruise was studied

Overall Quality Evaluation: The fruit quality is a concept of overall quality. Bigger but off-colour fruit and smaller but colourful fruit were often found in production. The fruit feature such as shape, size, and colour were dependent on the inherent character of its variety.

3. **Packaging and Labelling**: Automation extends to packaging and labelling processes, where machines can weigh, pack, seal, and label products efficiently. This reduces human error and enhances food safety, ensuring that products are properly sealed and labelled, meeting regulatory requirements.
4. **Cold Chain Management**: Maintaining the cold chain is crucial for preserving the quality of perishable goods. Automation systems can monitor and regulate temperature and humidity levels throughout the supply chain, reducing the risk of spoilage and extending shelf life.
5. **Quality Control**: Robotic arms and cameras can perform quality control tasks such as detecting bruised or damaged produce, removing contaminants, and ensuring that packaging is intact. This helps maintain product quality and reduces food waste.
6. **Inventory Management**: Automation is also streamlining inventory management processes. Automated systems can track inventory levels, predict demand, and optimize restocking, reducing the risk of overstocking or running out of products.

Benefits of Robotics and Automation:

1. **Improved Quality**: Automation ensures consistency in handling and processing, resulting in higher-quality products that meet consumer expectations.
2. **Enhanced Food Safety**: Automated processes reduce the risk of contamination and human errors, contributing to improved food safety standards.
3. **Reduced Labor Costs**: By automating labour-intensive tasks, farmers and processors can significantly reduce labour costs and address labour shortages.
4. **Extended Shelf Life**: Precise control of environmental conditions, especially in cold chain management, extends the shelf life of perishable goods.
5. **Minimized Food Waste**: Automation helps minimize food waste by ensuring that only high-quality produce reaches consumers and by optimizing inventory management.

Fig. 1 Automation and robotics system in Agriculture

Challenges and Future Prospects

While the integration of robotics and automation in postharvest management holds great promise, it also presents challenges. Initial investment costs, technical complexities, and the need for skilled technicians are hurdles that must be addressed. Additionally, ensuring that automation benefits are accessible to small-scale farmers and processors is crucial for widespread adoption. In the coming years, we can expect further advancements in robotics and automation technology, including the use of artificial intelligence for more sophisticated decision-making, greater adaptability to various crop types, and increased connectivity within the agricultural supply chain.

Conclusion:

The integration of robotics and automation into postharvest management represents a revolutionary shift in the realm of agriculture. This transformation not only amplifies efficiency but also elevates the standards of food quality, safety, and sustainability. With technology continually progressing, the agricultural industry stands on the brink of even more substantial advantages, rendering it an exceptionally captivating field to monitor in the context of the future of food production and distribution. The deployment of automation within postharvest procedures plays a pivotal role in preventing physical damage and reducing both physiological and pathological harm to the harvested produce. Moreover, automation demonstrates its prowess by expediting postharvest processes, thereby curtailing the duration during which perishable goods remain exposed to unfavourable conditions. Additionally, it bolsters the overall operational safety of human tasks involved in the handling of fresh horticultural produce, ultimately enhancing the overall facility's safety standards.

References

Kondo, N. (2006). Machine vision based on optical properties of biomaterials for fruit grading system. *Environmental Control in Biology*, *44*(3), 151-159.

Kondo, N. (2010). Automation on fruit and vegetable grading system and food traceability. *Trends in Food Science & Technology*, *21*(3), 145-152.

Kulkarni, A. A., Dhanush, P., Chetan, B. S., Gowda, C. T., & Shrivastava, P. K. (2020, February). Applications of automation and robotics in agriculture industries; a review. In *IOP Conference Series: Materials Science and Engineering* (Vol. 748, No. 1, p. 012002). IOP Publishing.

Kumar, A., & Gill, G. S. (2015, May). Automatic fruit grading and classification system using computer vision: A review. In *2015 Second International Conference on Advances in Computing and Communication Engineering* (pp. 598-603). IEEE.

Mahmud, M. S. A., Abidin, M. S. Z., Emmanuel, A. A., & Hasan, H. S. (2020). Robotics and automation in agriculture: present and future applications. *Applications of Modelling and Simulation*, *4*, 130-140.

Maldonado, A. I. L. (2010). Automation and robots for handling, storing and transporting fresh horticulture produce. *Stewart Postharvest Review*, *6*(3), 1-6.

Marinoudi, V., Sørensen, C. G., Pearson, S., & Bochtis, D. (2019). Robotics and labour in agriculture. A context consideration. *Biosystems Engineering*, *184*, 111-121.

McNulty, P., & Grace, P. M. (Eds.). (2009). *Agricultural Mechanization and Automation-Volume II* (Vol. 2). EOLSS Publications.

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AN OVERVIEW OF CARDAMOM MARKETING'S STRUCTURAL REORGANIZATION OF THE AUCTION SYSTEM FOR MORE TRANSPARENCY

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The economies of various nations that produce, export, and import spices, as well as our own, depend heavily on spices. One of the largest producers and exporters of spices worldwide is India. Additionally, a sizable amount of its manufacturing is used domestically. Cardamom is a spice that is grown on plantations for commercial purposes. The botanical names for it are "Elecaria Cardamom Maton" for little cardamom and "Ammomum Subulatum Roxburg" for giant cardamom. Only the lush, evergreen woods of the southern Indian states of Kerala, Karnataka, and Tamil Nadu are used to cultivate the little cardamom. In several Indian languages, cardamom is known by various names. It is referred to as "chhotielachi" in Hindi and Bengali, "yelakki" in Kannada, and elakkai in Tamil.

The "Queen of Spices" title is given to cardamom. It is grown in three significant locations: Kerala, Karnataka, and Tamil Nadu. Cardamom is one of the most important spices in India for economic growth. In Bodinayakanur, Theni District, Tamil Nadu, the Spices Board held its maiden cardamom e-Auction. In Vendamettu, Kerala's Idukki District, and Sakalespur, Karnataka, the second e-Auction facility was constructed. The marketing channels for cardamom, the roles of the cardamom auction, price volatility, and the introduction of e-Auction are discussed in this study.

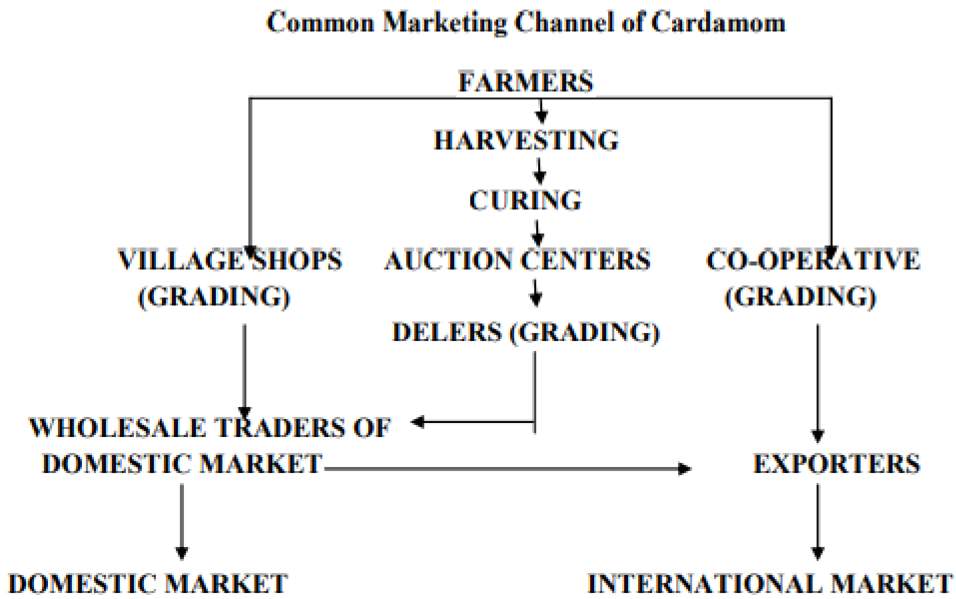
All cardamom varieties are used as flavorings in both food and beverages, such as spices used in cooking and as medicines. Cardamom has an unmistakably intense flavor and a very sweet-smelling, resinous aroma. Due to its high cost and low volume, green cardamom is one of the most costly spices.

India's Tamil Nadu and Kerala both offer e-auction websites for a range of products, including cardamom. Farmers and dealers frequently use these internet marketplaces for cardamom sales and purchases. Please be aware, though, that since then, the specifics and procedures may have changed or developed. For the most recent information, it is crucial to contact the relevant state agricultural agencies or organizations.

Marketing of Cardamom

The Spices Board has been instrumental in modernizing the cardamom marketing process, which mostly uses an auction method. The Spices Board Officers stationed in auction centers regularly monitor auctions to verify that rules and regulations are being followed with the aim of protecting producers' interests and ensuring that exporters have access to exportable grades.

The proper operation of the marketing system is ensured through regular communication with producers, auctioneers, merchants, and exporters. Other sector-related difficulties are occasionally handled by close communication with the relevant authorities. The Spices Trading Corporation Ltd. began holding auctions in Bodinayakanur in 1989–1990 in an effort to simplify the auction procedure and guarantee prompt payment. This has aided in making high-quality cardamom available to exporters so that producers may be paid promptly.



The cardamom marketing system has been characterized by a big number of sellers (both large and small), a limited number of exporters—many of them are dealers and just a tiny number of them are also growers—a huge number of dealers, and only a few auctioneers. One of the key players in the marketing of cardamom who connect the product's consumers and sellers are auctioneers.

Another crucial component in the cardamom marketing chain is the exporters. The Cardamom (Licensing and Marketing) Rules of 1977 state that exporters are not permitted to buy cardamom directly from a producer or an auctioneer unless that person has a license to sell the spice. Since the license is only valid for a year before needing to be renewed in order to continue doing business, the number of exporters changes from year to year.

The Role of Auctioners

The auctioner brings together the producers who have a registration certificate and the merchants who have a license from the Spices Board to trade in cardamom (also known as "bidders"). Cardamom merchants are prohibited under cardamom regulations from buying the spice from estate owners who have not registered their estates or from auctioneers who have not been granted licenses by the Spices Board (previously the Cardamom Board). Furthermore, no dealer may request or accept any payment from cardamom growers or auctioneers, including discounts or commissions.

Whether through a discount or commission, a dealer taking part in the auction must pay the whole value for the complete amount of the cardamom producers or auctioneers. A merchant taking part in the auction must pay the full amount for all of the cardamom in the lot he has acquired.

Function of Auctions

A prominent spice used in many dishes and traditional medicine, cardamom is traded and distributed in large part thanks to auctions. The following are some major purposes of cardamom auctions:

- **Price Discovery:** Auctions offer a venue for buyers and sellers to learn the cardamom market price. The price is established by competitive bidding depending on the present dynamics of supply and demand.
- **Equal Access to the Market:** Through auctions, all cardamom growers, regardless of their size or location, are guaranteed equal access to the market. Along with bigger commercial producers, small-scale farmers can participate, encouraging fair competition.
- **Transparency:** Auctions encourage openness in pricing and business dealings. Prices are often clearly posted, making it possible for participants to observe the going market prices, hence reducing the likelihood of price manipulation and unethical business practices.
- **Quality Control:** Grading criteria are frequently in place at cardamom auctions. As a result, customers are guaranteed to obtain cardamom of a certain quality, which is significant for export markets where consistency in quality is essential.
- **Effective Distribution:** Auctions aid in the effective distribution of cardamom from growers to consumers. Local dealers, processors, exporters, and even consumers may fall under this category.
- **Market Access:** Auctions give purchasers, including domestic and foreign merchants, a centralized marketplace where they may purchase cardamom in large quantities, making it simpler for them to satisfy their supply demands.
- **Risk management:** Both buyers and sellers can manage price risk with the use of auctions. Cardamom sellers may obtain reasonable pricing for their product, and buyers can find a trustworthy supplier.
- **Economic Impact:** Cardamom auctions support the growth of the local economy in cardamom-growing regions. Farmers receive revenue from them, and local economies are supported.

- **Regulation and Compliance:** Regulators frequently monitor auctions to make sure they adhere to applicable laws and regulations. By doing this, it may be possible to stop the sale of inferior or tainted cardamom.
- **Data collection:** Auctions offer useful information about cardamom pricing and market patterns that may be utilized for decision-making and planning by a variety of stakeholders, including policymakers, academics, and business owners.
- **Market Integration:** Local cardamom markets can be integrated into regional and international supply chains through auctions. For both producers and buyers, this may result in more possibilities and market access.

In conclusion, cardamom auctions provide crucial venues for the trade and distribution of the spice, enabling fair pricing, quality control, and quick market access while advancing the cardamom business as a whole.

References

Kumar, N (2001). Indian Software Industry Development: International and National Perspective‟, Economic and Political Weekly, 36(45): 4278-4290.

Wade, RH (2004). Is Globalization Reducing Poverty and Inequality?,‟ World Development, 32(4), 572-596.

Joseph,K.J. (2010) Inclusive Innovation Systems in Plantation Sector: The State of Database and its Limits,‟ NRPPD Discussion Paper, Center for Development Studies.

Joseph,K.J (2011) Commodity Markets and Computers: “An Analysis of e-Auction in Cardamom Marketing from an Inclusive Innovation System Perspective”. pp 17-24.

Dr. T.Ramalakshmi and S.Kanchanadevi. (2019): “Cardamom Marketing A Structural Reorganization In Auction System For Greater Transparency - A View”

6.https://indianculture.gov.in/food-and-culture/spices-herbs/cardamom-queen-spices#:~:text=Cardamom%20or%20Elettaria%20Cardamomum%20Maton,to%20the%20family%20of%20ginger.

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SMART FARM MECHANIZATION: REVOLUTIONIZING AGRICULTURE FOR A SUSTAINABLE FUTURE

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Abstract:

Smart farm mechanization is a paradigm-shifting strategy that combines cutting-edge technologies into agriculture to increase production, sustainability, and efficiency. These technologies include robotics, sensors, artificial intelligence, and the Internet of Things (IoT). This article examines the idea of smart farm mechanization, emphasizing its essential elements and advantages. Smart farm mechanization tackles important issues facing contemporary agriculture by maximizing resource utilization, minimizing waste, and facilitating data-driven decision-making. Although it has many benefits, there are also drawbacks to take into account, including start-ups fees and data security. Smart farm mechanization has the potential to change agriculture in an era of rising global population and environmental concerns, providing food security and a sustainable future. With the combination of quantum computing and cutting-edge genetic engineering, smart farm mechanization is set to progress even further in the future, enabling crops and livestock to be precisely adapted to climatic conditions. A further benefit of the widespread adoption of smart farm mechanization is that it may encourage data sharing and collective intelligence for the sustainable management of agricultural resources on a global scale by creating networks of cooperative, interconnected farms.

Keywords: Agriculture technology, Artificial intelligence, Robotics, Internet of Things (IoT), Food security.

Introduction

Agriculture has come a long way from its humble beginnings, evolving into a highly complex and technology-driven industry. One of the most significant advancements in modern farming is smart farm mechanization, a transformative approach that harnesses cutting-edge technologies to optimize agricultural processes (Malhotra & Firdaus, 2022). In a world where the global population continues to grow, and climate change poses unprecedented challenges, smart farm mechanization is a critical tool for ensuring food security, sustainability, and increased productivity (Hanjra & Qureshi, 2010). This article explores the concept of smart farm mechanization, its benefits, and its potential to reshape the future of agriculture.

Agriculture, the cornerstone of human civilization, has undergone a remarkable transformation throughout history (Barker, 1985). From the humble beginnings of manual labor and basic tools to the modern, technologically advanced practices of today, agriculture has continuously evolved to meet the ever-growing demands of a burgeoning global population. Now, in the 21st century, a new chapter in the agricultural revolution is unfolding, driven by a convergence of cutting-edge technologies and innovative practices. Smart farm mechanization, a concept at the forefront of this revolution, stands as a beacon of hope for addressing the complex challenges that agriculture faces in the modern world.

Smart farm mechanization represents a paradigm shift in the way we approach agriculture. (Blackmore et al., 2005) At its core, it is the integration of advanced technologies into every aspect of farming, from planting to harvesting and beyond. This integration extends beyond the use of machines; it encompasses a comprehensive network of sensors, artificial intelligence, data analytics, and connectivity that allows for the intelligent management of agricultural processes.

As our world grapples with critical issues like climate change, resource scarcity, and the need to feed a population projected to reach nearly 9 billion by 2050, the role of agriculture in ensuring a sustainable future cannot be overstated (Chartres & Noble, 2015). The traditional practices that sustained us for centuries are increasingly unsustainable in the face of these challenges. Smart farm mechanization emerges as a transformative solution, offering a way to maximize agricultural efficiency, minimize waste, and reduce the environmental footprint of farming (Malhotra & Firdaus, 2022).

In this comprehensive exploration of smart farm mechanization, we will delve into the core principles, technologies, benefits, challenges, and the future prospects of this ground-breaking approach to agriculture. It is a journey into the heart of a revolution that holds the promise of not only feeding the world but also doing so in a manner that safeguards our planet's fragile ecosystems for generations to come.

Understanding Smart Farm Mechanization

Smart farm mechanization refers to the integration of advanced technologies into agricultural machinery and processes to improve efficiency, productivity, and sustainability. This approach leverages various technologies, including robotics, sensors, artificial intelligence, big data analytics, and the Internet of Things (IoT), to create intelligent and automated farming systems. These systems can perform tasks such as planting, harvesting, irrigation, and pest control with precision and minimal human intervention.

Precision Agriculture: Precision agriculture involves the use of GPS technology, sensors, and data analytics to optimize farming operations. Farmers can collect data on soil conditions, crop health, and weather patterns to make informed decisions about planting, fertilizing, and irrigating, resulting in reduced resource wastage and increased crop yields (Zhang et al., 2002).

Autonomous Machinery: Autonomous tractors, drones, and robots are becoming increasingly common on smart farms. These machines can perform tasks with remarkable accuracy, working around the clock if necessary, and reducing labor costs while enhancing efficiency (Ghobadpour et al., 2022).

IoT Sensors: IoT sensors are strategically placed throughout the farm to gather real-time data on soil moisture, temperature, and humidity. This data allows farmers to make timely adjustments to irrigation and other operations, conserving water and energy (Pal et al., 2023).

Artificial Intelligence (AI): AI algorithms process vast amounts of data to provide insights into crop and livestock management. These systems can predict disease outbreaks, optimize feeding schedules, and even detect and control pests and weeds (Mishra, & Mishra 2023).

Benefits of Smart Farm Mechanization

Increased Productivity: Smart farm mechanization enables farmers to produce more with less. Optimized processes, precision farming techniques, and the use of data-driven decisions result in higher crop yields and greater efficiency.

Resource Conservation: The precise application of resources such as water, fertilizers, and pesticides minimizes waste, reducing the environmental impact of farming. This is especially crucial in the face of increasing water scarcity and environmental concerns.

Labor Savings: Automated machinery and robotics reduce the need for manual labor, addressing the labor shortages often faced by the agricultural industry. This can make farming more attractive and sustainable in the long term.

Improved Sustainability: By optimizing resource use, minimizing waste, and reducing the carbon footprint of farming operations, smart farm mechanization contributes to greater sustainability and environmental responsibility.

Data-Driven Decision Making: Access to real-time data allows farmers to make informed decisions about their operations, leading to better outcomes and higher profitability.

Challenges and Considerations

While smart farm mechanization offers numerous benefits, it also presents challenges and considerations. The initial cost of implementing these technologies can be high, potentially limiting access for small-scale farmers. Additionally, there are concerns about data security, as the collection and storage of sensitive agricultural data become more prevalent.

Conclusion

Smart farm mechanization represents a significant step forward in the evolution of agriculture. By harnessing the power of advanced technologies, farmers can increase productivity, conserve resources, and reduce environmental impact. This approach is not only essential for meeting the growing global demand for food but also for addressing the challenges posed by climate change and resource scarcity. As smart farm mechanization continues to advance, it holds the promise of a more sustainable and prosperous future for agriculture. It's not just a technological revolution; it's a necessity for the survival of our planet and future generations.

References

Malhotra, K., & Firdaus, M. (2022). Application of Artificial Intelligence in IoT Security for Crop Yield Prediction. ResearchBerg Review of Science and Technology, 2(1), 136-157.

Hanjra, M. A., & Qureshi, M. E. (2010). Global water crisis and future food security in an era of climate change. Food policy, 35(5), 365-377.

Barker, G. (1985). Prehistoric farming in Europe. Cambridge University Press.

Blackmore, S., Stout, B., Wang, M., & Runov, B. (2005, June). Robotic agriculture–the future of agricultural mechanisation. In Proceedings of the 5th European conference on precision agriculture (pp. 621-628). Wageningen, The Netherlands: Wageningen Academic Publishers.

Chartres, C. J., & Noble, A. (2015). Sustainable intensification: overcoming land and water constraints on food production. Food security, 7, 235-245.

Malhotra, K., & Firdaus, M. (2022). Application of Artificial Intelligence in IoT Security for Crop Yield Prediction. ResearchBerg Review of Science and Technology, 2(1), 136-157.

Zhang, N., Wang, M., & Wang, N. (2002). Precision agriculture—a worldwide overview. Computers and electronics in agriculture, 36(2-3), 113-132.

Ghobadpour, A., Monsalve, G., Cardenas, A., & Mousazadeh, H. (2022). Off-road electric vehicles and autonomous robots in agricultural sector: trends, challenges, and opportunities. Vehicles, 4(3), 843-864.

G Pal,T Patel, H. D Singh,., M Mishra, & A Pal. (2022). Bluetooth Module-Based Wearable Heatstroke Alert System Based on Physiological and Environmental Parameters for Agricultural Workers. Res. Jr. of Agril. Sci., 13(5): 1388-1395.

Mishra, H., & Mishra, D. (2023). Artificial Intelligence and Machine Learning in Agriculture: Transforming Farming. Bhumi Publishers. 1, 1-168.

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INDISPENSABLE ROLE OF THRESHERS IN FARMERS' LIVES

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Introduction:

Threshers are a type of agricultural machine used to separate grain from harvested crops [2]. The first threshing machine was invented in Great Britain in the 1780s" [1]. Threshers have since evolved to become more efficient and effective, greatly simplifying the task of separating grain from crops such as wheat, rice, and corn.

Manual Threshing to Semiautomatic Threshing

Before threshers, farmers were using hand tools such as sickles, scythes, and flails to harvest crops. They spend hours or even days in manually separating the grain from the chaff, a process known as threshing [3]. This was a laborious and time-consuming task that required a great deal of physical effort and skill. Threshers have indeed automated the threshing process, enabling farmers to separate grain from chaff efficiently. Powered by engines and available in various sizes and designs, modern threshers utilize rollers and beaters to carry out the separation task. The grain is collected in a hopper or bag, while the chaff is expelled from the machine [8]. Moreover, threshers have reduced the physical demands of farming, thereby minimizing the risk of injuries and strain for farmers [7]. With the ability to process crops quickly and requiring fewer workers, threshers help alleviate the challenges associated with labour shortages. This aspect is particularly valuable in agricultural areas where the availability of labour is limited [4].

Time and Labour Savings:

The adoption of threshers brings significant benefits to farmers, as they can process larger quantities of crops in a shorter time, leading to increased overall productivity. One key advantage is the reduction in crop loss during the threshing process. Traditional methods such as trampling or beating could result in grain damage or loss. On the other hand, threshers are designed to separate the grain from the crop gently [6]. The time and labour saved by utilizing threshers provide farmers with the opportunity to focus on other critical farming activities, including planting, irrigation, and crop management. This increased attention to crop management can contribute to improved yield and crop quality. Furthermore, by reducing the labour requirements for threshing, farmers can potentially lower their labour costs, which can have a significant impact on their overall profitability.

Threshers with Higher Feeding and Threshing Capacity

Increased Efficiency:

The utilization of rotating beaters or blades in threshers enables a gentle separation process, effectively removing straw, chaff, or husk from the grain, resulting in a high-quality yield. This mechanism not only streamlines the threshing process but also ensures that the yield maintains its desired quality standards Inadequate harvesting practices or inefficient threshing methods can lead to post-harvest losses and reduce grain quality [5]. Grain damage or breakage during threshing can negatively impact the overall quality of the yield, ultimately affecting farmers' profits. By expediting the threshing process, threshers enable farmers to handle larger volumes of crops within a shorter period, thereby boosting overall productivity and profitability. The increased efficiency provided by threshers allows farmers to allocate saved resources to other essential farming activities, thereby enhancing their agricultural operations.

Improved Grain Quality:

An essential machine in the agricultural sector due to their ability to maintain the quality of grains by providing a uniform and consistent separation of grain from the crop, which helps prevent contamination or damage. Compared to manual separation methods, the use of threshers has been found to reduce the chances of human error, thus ensuring the preservation of grain quality. The separation process removes impurities resulting in higher-quality grains that fetch better prices in the market. This is particularly important for farmers who rely on selling their produce to generate income, as higher-quality grains command a premium price. Threshers have also been found to be crucial in meeting food safety regulations by ensuring that grains meet stringent quality standards. This enables farmers to expand their market opportunities and access buyers who prioritize quality assurance.

Versatility and Adaptability:

Threshers offer a wide range of sizes and types to meet the diverse requirements of farmers in their agricultural operations [9]. The selection of a suitable thresher is contingent upon the scale of farming operations and resource availability. Threshers can be powered by electricity, diesel engines, or tractors, providing flexibility based on resource accessibility. The adaptability of threshers is a key advantage that contributes to their popularity among farmers. These machines can be adjusted and modified to accommodate various crop types, including wheat, rice, maize, and pulses. This versatility enables farmers to process multiple crops using a single machine, optimizing productivity and minimizing costs.

Empowering Small-Scale Farmers:

Mechanizing the grain separation process through the use of threshers reduces the dependence on manual labour and increases the output of the farm. This empowerment can significantly help small-scale farmers improve their economic condition and enhance their ability to compete in the market. Small-scale farmers who rely on manual labour for the threshing process can benefit immensely from threshers. This, in turn, helps farmers generate more income, which is crucial for their economic well-being [4]. This helps small-scale farmers meet the quality standards set by food safety regulations, which can expand their market opportunities.

Technological Advancements:

Modern threshers have undergone significant technological advancements, incorporating features such as adjustable settings, built-in cleaning mechanisms, sensors, and digital technologies to enhance their efficiency and usability in grain separation. The inclusion of adjustable settings allows farmers to customize the machine according to specific crop varieties and grain sizes, optimizing the separation process and improving grain quality. Built-in cleaning mechanisms effectively remove impurities during threshing, ensuring high-quality grains that meet market standards. The integration of sensors and digital technologies enables automatic adjustments based on crop parameters, leading to consistent separation, minimized grain damage, and reduced wastage. Additionally, the integration of threshing and winnowing systems into a single machine saves time and resources. Overall, these advancements make modern threshers more user-friendly, efficient, and capable of delivering higher yields, thereby maximizing returns on investment for farmers.

Conclusion

Threshers have transformed the lives of farmers by simplifying the labour-intensive task of grain separation. Their time-saving nature, improved efficiency, and ability to produce high-quality grains have made them indispensable in modern agriculture. Threshers empower farmers, particularly small-scale ones, by reducing labour requirements and increasing productivity.

References

Anonymous (2022). First threshing machine. Retrieved on 15 May, 2023, from https://allfamousbirthday.com/faqs/who-invented-the-first-threshing-machine-in-1784/

Anonymous (2023). Threshing machine. Retrieved on 15 May, 2023, from https://en.wikipedia.org/wiki/Threshing_machine#:~:text=A%20threshing%20machine%20or%20a,make%20the%20seeds%20fall%20out

Anonymous (2023). Scythe. Retrieved on 15 May, 2023, from https://www.merriam-webster.com/dictionary/scythe#:~:text=1%20of%202,noun,angle%20to%20a%20 long%20handler%20 handle

Aryal, J. P., Rahut, D. B., Thapa, G., & Simtowe, F. (2021). Mechanisation of small-scale farms in South Asia: Empirical evidence derived from farm households survey. *Technology in Society*, 65, 101591.

Kumar, D., & Kalita P. (2017). Reducing postharvest losses during storage of grain crops to strengthen food security in developing countries. *Foods*, 6**(1)**:8. https://doi.org/10.3390/foods6010008

Kumar, D., Dogra, R., Dogra, B., & Singh, H. (2012). Performance Evaluation of Multi-crop Thresher for Threshing Radish (Raphanus Sativus). Agricultural engineering today, 36**(3)**, 39-44.

Nag, P. K., & Nag, A. (2004). Drudgery, accidents, and injuries in Indian agriculture. *Industrial Health*, 42**(2),** 149–162. doi:10.2486/indhealth.42.149

Nemo, N. (2019). Design of wheat threshing machine. Retrieved on 16 May, 2023, from https://www.academia.edu/39306876/Design_of_wheat_threshing_machine

Rajkhowa, P., & Kubik, Z. (2021). Revisiting the relationship between farm mechanization and labour requirement in India. *The Indian Economic Review*, 56, 487–513.

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