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Research Article

Development of Low-Cost Natural Cooling Chamber for Preservation of Vegetables and Fruits in Rural Area

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ABSTRACT

India is an agricultural-based country and this output creates a deep impact on the Indian economy and the rest of the factors. Hence upgrading the traditional farming techniques by the use of technology should be our priority. In the case of fruits and Vegetable farming, it is seen that most of the output gets decomposed or gets dried after harvesting because of various problems like no preserving units into the farms, irregular timings of transportation facilities, wrong methods of storage, etc. This directly affects the fruits and vegetables by lowering the physiological loss in weight as well as by damaging their quality. So it is very important to find out a good preserving unit to increase the shelf life and to maintain the freshness of fruits and vegetables for a longer time. As well as, it is very difficult to install the refrigerating systems into the farms. It would cost a lot too. Hence we have to make this possible by the use of natural things which would be easily available to the farmers and very easy to build. These conditions can be achieved by installing a Natural cooling chamber. It provides higher humidity and lower temperature on the inner side of the chamber which would not promote any physiological loss in weight as well as other metabolic processes, resulting increase of shelf life by maintaining 10°C–15°C temperature below the ambient temperature. Also, it is very easy to build, has less maintenance, requires noelectricity, and has a minimum cost of installation. Farmers would have a really good advantage of this natural preserver.

Keywords: Cooling Chamber, Evaporative cooling, Preservation, Zero Energy

Introduction

Food, shelter, and clothes are the basic needs of human life among which food is the most important thing to stay alive. That is why farming started from the stone-age, but to obtain a better amount of good crops from the field, a good preservation technique is very important. The main problem in developing the countries is lack of technology and growth of population due to the growth of population the need for food increases.[1] India is the

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2nd largest country in population growth and having good conditions for producing various crops, especially the mostly horticultural production. In that production, 20%–30% of total fruits and vegetable production is lost after the harvesting[2] due to lack of warehouses, cold storages, and transportation systems. The profit from this production is lesser than the actual profit. There are so many methods that are used to store the horticultural products. Such as, the chemicals like bio-chemicals which are used to maintain the freshness and durability of products. The most common or traditional methods to store the products are cold storage and warehouses which work on the different cycles of refrigeration like VCR, VAR, etc.[3] In this system, the temperature is diminished up to 4°C–5°C. Another route for storage is under-cooling, quick cooling to +2°C–+4°C. It is done for transportation at a large distance or before placing it into storage. Some areas having an underground storage system i.e. the dig is provided on the ground and products are stored. In these methods there are some issues i.e. refrigeration systems contain a supply of electricity continues, various refrigerants are used to drive the systems due to which the carbon emission takes place and which is very harmful to nature. Due to chemicals, there are many problems faced by human beings many diseases occur due to that and the systems are not economical. India has most of the rural areas in that areas lack the technology and other resources like electricity, internet facilities, and storage systems. There is no storage systems are available to store the farming products. Due to that, the products get lost. To overcome this problem we have prepared one system to store the products for a longer time and maintain their freshness and durability. The system is working on the principle of Evaporative Cooling method[4] by using this method we made a preservation cooling chamber which doesn't require any energy or no pollution will be.

The natural cooling chamber is very easy to install and very easy to construct. It is made by using simple material that is available in an easy way. It contains less production cost comparing to other methods having less maintenance. It is made up of bricks, cement, mud, sand, water, and jute. The system is useful for farmers to storage horticultural products. This system is an energy-free and one-time investment. Also in village areas many brokers are sell and supply the horticulture products for this brokers preservation cooling chamber is useful. There is a lack of supply chain so to overcome this problem this system is useful to maintain the freshness and durability of horticultural products. The objective of this study was to minimize the temperature by controlling the water operation. The system is operating on the principle of evaporative cooling which is defined as the water absorbs the heat from the atmosphere and there is an ability to convert it into latent heat and cooling effect get produced so water is the main ingredient in our system. The cooling chamber is constructed and contains a cavity between the outer and inner wall in this cavity we fill various material like crushed bricks, sand, Jute, etc. and water supplied over it through the pipe. Inside the chamber, we keep the fruits or vegetables for preservation. Many products are produced on the farm like, tomato, coriander, onion, potato, green vegetables, apple, mango, oranges, etc. The time after harvesting and before getting damaged of fruits and vegetables is known as the shelf life of the product and having different parameters of minerals, carbohydrate, proteins, etc. to maintain their properties, freshness, and durability the products must be store below ambient temperature i.e. 10°C–15°C.[1]

According to the market survey the horticultural products are having maximum loss during travelling and because of lack of preservation provided. Generally, in our region, we have fruits and vegetable markets once in a week so, the farmers and retailers have to maintain the freshness and durability of fruits and vegetables for about a maximum 6–8 days. But due to the wrong techniques of storing these products the maximum amount among them get damaged. So, to overcome this loss and to prevent the damage natural cooling chamber can be used. The rural areas having problems in preserving these products at a low temperature can construct the chamber in their farms, homes and it is very profitable for the farmers because they have to do a one-time investment. In cities when the supply of horticultural products is done then the retailers generally do not have or have a very limited storing facility. In such conditions, they can construct the cooling chamber in the market and store the products. This can also be beneficial for small scale food industries. This chamber does not require any electricity to maintain temperature and humidity, thus is considered as a natural cooling system which is profitable for farmers, retailers, and small businesses.

As we live in Kolhapur District situated in Maharashtra. We researched climatic and geographical conditions. In these conditions, we collected data like DBT (Dry Bulb Temperature), WBT (Wet Bulb Temperature), Relative Humidity, Humidity, and Geographical Location, Rainfall, and Area. This data proved to be helpful in the designing and orientation of our natural cooling system. Table 2 shows the climatic and geographical conditions of the Kolhapur District.

All the gathered information was tabulated after the survey and study about vegetables and fruits (Table 1). We studied all the data regarding shelf life, temperature, and humidity of vegetables and fruits. With the help of this data, a prototype of the natural cooling chamber was prepared. A lot of constraints were there because of the sudden lockdown imposed due to COVID-19. In this lockdown, the spoilage of fresh fruits and vegetables became a serious problem. The massive quantity of fruits and vegetables were spoiled every day due to the lack of proper infrastructure for processing and post-harvesting management. The spoilage of fruits and vegetables can be controlled by reducing the storage temperature and increasing the relative humidity. Hence, we developed a natural cooling chamber for farmers and retailers to avoid the spoilage of fruits and vegetables. So it will be more beneficial to farmer and retailer.

changes its phase from liquid to gas. This process is known as evaporative cooling. The water stored latent heat and absorbs heat from other surfaces or from the environment which is sensible heat. When water absorbs enough heat, the extra heat is released by water and provides cooling to the system. The natural cooling chamber is working on this principle. This is one type of evaporative cooler to maintain, store, and increase the shelf life of vegetables and fruits. It is natural processes to maintain vegetables and fruits without using electricity.

Table 1.Products and their shelf life, Storage Temperature and Relative Humidity Required for Fruits and Vegetables

S. No.	Products	Self-Life	Storage Temperature (°C)	Relative Humidity (%)
1.	Tomato (Ripe)	4–7 Days	7–12	85–95
2.	Tomato (Green)	12–20 Days	12–20	85–95
3.	Potato	2–5 Months	5–12	93
4.	Onion	1–8 Months	0	65–70
5.	Beans (Green)	7–10 Days	5–7	90–95
6.	Carrot	2–5 Months	0	90–95
7.	Pepper	2–3 Weeks	7–10	90–95
8.	Cucumbers	10–14 Days	7–10	90–95
9.	Coriander	2–4 Days	5–10	90–95
10.	Apple	3–8 Months	1–10	85–90
11.	Mangos	2–3 Weeks	12	85–90
12.	Pineapples	2–4 Weeks	7–12.5	85–90
13.	Watermelons	2–3 Weeks	4.4–12	90
14.	Bananas (Ripe)	3–8 Days	5–14	90–95
15.	Bananas (Green)	1–2 Weeks	7–20	85–90

Table 2.Climatic and Geographical Conditions for Kolhapur District

S. No	Parameters	Climatic and Geographical Condition (Kolhapur)
1.	DBT Average	28.83°C
2.	DBT Maximum	33.7°C
3.	DBT Minimum	25°C
4.	RH Range	28-81
5.	Rainfall (MM)	1500
6.	Wind Speed Avg. (KMPH)	5
7.	Geographic Location	16°41’30”N, 74°14’00”E
8.	Population	549,293
9.	Area	66.82 km^2
10.	WBT	31.7°C

Evaporative Cooling

Evaporative cooling is a process in which heat is removed from a surface by the evaporation of water. Water can absorb lots of heat without changing phases, allowing it to remove heat from the surface it is on and water

Figure 1 shows the diagram for the storage system working on the principle of evaporative cooling. Water is supplied throughout the cavity and vegetables and fruits are stored in the chamber.

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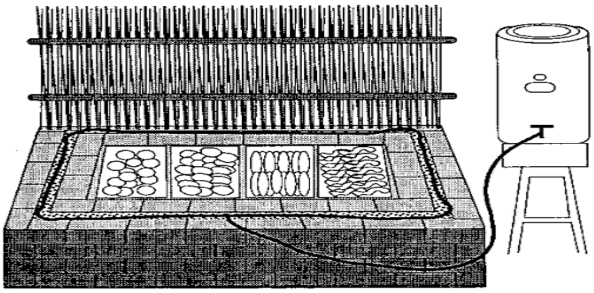

Figure 1.Natural cooling Chamber on Evaporative Cooling[8]

Psychometric Chart for Evaporative Cooling System

Evaporative Cooling takes place along the lines of constant wet-bulb temperature or enthalpy as there is no change in the amount of energy in the air. The energy in merely converted from sensible energy to latent energy. The moisture content of the air increases as the water evaporates which results in an increase in relative humidity along a line of constant wet-bulb temperature. By taking a set of conditions and applying the process of evaporative cooling to them. Figure 2 shows the psychometric condition for evaporative cooling.

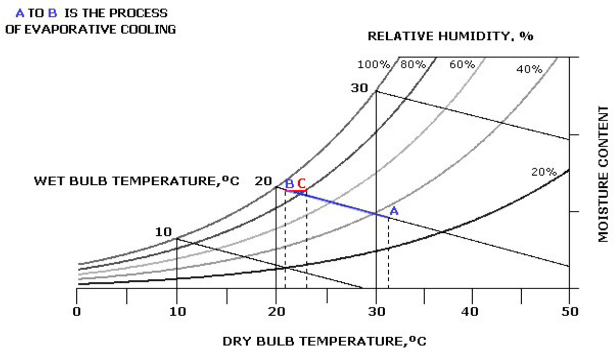

Figure 2.Psychometric Chart for Evaporative Cooling System

In this chart, the process A to B describes the dry bulb temperature of entering the air is 31°C and the leaving temperature is 21°C. So, the temperature difference is up to 10°C, and the system gets cooled. This concept is very useful for natural cooling chamber.

Litreture Review

M.P. Islam, T. Morimoto, K. Hatou[4]- As per the examination and investigation of this paper, within the temperature of the ZECC is cooled by adding water to sand and zeolite-based filler between the block dividers dependent on the standards of a characteristic evaporative cooling system. The target of this investigation was to limit the temperature of the ZECC by controlling watering activity. In this technique, dynamic changes within the temperature, as influenced by the watering system and outside temperature, were first recognized utilizing the neural system, and afterward, the ideal worth, which limited the goal work, was resolved through the reproduction of the distinguished neural-organize model utilizing hereditary calculation. Thus the creators inferred that the ZECC with the ideal ON-OFF watering methodology broadened the time of usability of untreated tomato from 7–16 days. In this way, a ZECC streamlined by utilizing neural systems and hereditary calculations helps put away tomato with no electric vitality. Consequently, the methods utilized by the creator are acceptable and valuable for ZECC.

Sanjay Singh, Singh A. K. Joshi H. K, Bagle B. G, More T. A[5]- As per the investigation of this paper, the impact of ZECC alongside post-collect medicines including $CaCl_2$, mustard oil, and K_2SO_4 independently on the timeframe of realistic usability and natural product quality properties of Indian gooseberry or Aonla (*Emblica officinalis Gaertn.*) during capacity under a semi-dry biological system of Gujarat was examined. Natural products treated with 1.5% $CaCl_2$ and put away in ZECC recorded least PLW (16%), decay misfortune (16.5%), respiratory movement (83 mg CO_2/kg/h), and showed 11 days of the time of usability, while untreated control had 6 days monetary life. The obtained result is so good and fulfills the target. It was firmly trailed by 1% $CaCl_2$ + ZECC treatment. Natural products put away in ZECC recorded 9 days' timeframe of realistic usability. Most elevated breath rates were in charge (88.1 mg CO_2/kg/h) on the 13th day of capacity. Consequently, it tends to be reasoned that, the natural products treated with $CaCl_2$ 1.5% and put away in ZECC (T6) could be put away to 11 days under the semi-dry environment of Gujarat. This is a decent report done by the creator which helped us a great deal.

Laishram Kanta Singh (Indian Institute of Technology Kharagpur)[6] An overview of a specific region was done. Because of the absence of legitimate stockpiling and preparing offices in Churachandpur locale, a lot of plant produce goes squander. Refrigerated cold stockpiling is considered as the best method for storing horticultural produce, but it requires good enough capital investment. The Zero Vitality Cool Chambers (ZECC) are a basic, minimal effort, viable, and ranchers' well-disposed innovation which can be effectively adjusted by the ranchers. The preliminaries were directed in Churachandpur area, Manipur in cabbage, broccoli, and tomato for vegetable yields, while organic product crops taken for the examinations were the banana, pineapple, and energy natural product. Under the preliminary, the timeframe of realistic usability of cabbage, broccoli, and tomato was 5d, 2d, and 7d, separately under room condition and following vegetables could be improved their period of usability by holding under ZECC condition at 11d, 7d and 15d, individually when contrasted with the room condition. The physiological misfortunes in weight (PLW) of these vegetable yields were additionally broke

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down for both room and ZECC conditions. The PLW of organic product crops like pineapple at room condition was 6.8% and 3.2 % under ZECC condition. The PLW of energy foods grown from the ground crops under room conditions were at 7.5% and 4.2 % individually and 5.5 % and 2.4%, separately under ZECC condition. If there should be an occurrence of vegetable harvests, PLW for cabbage, broccoli, and tomato under room conditions were 5.5, 15.8, and 6.7 %consecutively, and PLW could be diminished at 3.2, 3.7 and 2.3 %, individually under ZECC condition when contrasted with the room condition. Henceforth we can presume that PLW gone diminishing as the foods grown from the ground are kept in ZECC likewise, the timeframe of realistic usability got expanded.

Prof. Susanta K. Roy and Prof. Emeritus[7]- The author contemplated the standard of evaporative cooling and actualized it into ZECC. As per the guidelines of evaporative cooling, as water vanishes it has an impressive cooling impact and quicker the pace of dissipation more prominent the cooling. Evaporative cooling happens when air, which is not immersed with water, disregards a wet surface. Water dissipates into the air raising its stickiness and the same time cooling the bed. The effectiveness of the evaporative cooler relies upon the dampness of encompassing air. Exceptionally dry, low moistness air can assimilate a ton of dampness so significant cooling happens. An extraordinary instance of air that is soaked no vanishing can happen and no cooling happens. In principle, the most reduced temperature that can be reached is wet bulb temperature. Cool chambers can lessen temperature by 10–15°C and keep up high moistness of about 95% that can build a timeframe of realistic usability and hold the nature of plant produce. Henceforth if appropriately engendered and received accessibility of nutritious products of the soil will increment and the shopper will save money.

K.V. Vala, F. Saiyed, D.C. Joshi[2]- As indicated by this exploration evaporative cooling is an acceptable framework for the earth. By their examination evaporative cooling is anything but difficult to work, moderate, and proficient for ranchers. In this audit, a distinctive evaporative cooling framework created, their development, materials, and productivity to build the period of usability of vegetable and natural products. They have presumed that the evaporative cooling framework could be proficient for the products of the soil where the atmosphere is hot and dry, can likewise utilize in other climatic conditions. Furthermore, it is minimal effort development and no operational expense and it has great preferences over mechanical refrigeration that it very well may be utilized in any location as a cool stockpiling reason.

Yousef Al Horr, Bourhan Tashtoush, Nelson Chilengwe, Mohamed Musthafa[3]- In this paper, they have concentrated tentatively on the presentation of an aberrant evaporative cooling outside air-taking care of unit at various methods of activity under different climatic conditions experienced in Qatar. They have done various methods of activity that are finished by pre-treatment of optional air by utilizing fog, water shower, and so forth. It is discovered that the wet methods of activity can set aside to 43% of the cooling. They have finished up than in the state of low temp and high relative dampness, the cooling of the water shower mode is 41.1% more than for the fog. The contrast between high and low dry bulb methods of activity is just 1.1%. The utilization of aberrant evaporative cooling gives significant cooling load decrease whenever consolidated in FAHU's working in a hot atmosphere.

Adams Abdul-Rahaman, Nasiru Alhassan, Agyemang Dua Andrews[1]- In this, they have concentrated on Post harvest Stockpiling to build deals of agriculture item and gives low market costs during the gathering season. With their view the impact of utilizing zero vitality cold chamber and House Hold Cooler (HHF) on weight reduction, shading changes, and buyer acknowledgment of new natural products. An absolute 105 organic products were tested up to eight 8 days. The single factor investigation of difference was utilized at a 5% alpha level. HHF keep up a normal shade of 2.0 all through the whole test time frame, and weight reduction (4.90%) on the multi-day. The viability of ZECC and HHF as a capacity condition for the nature of banana organic products was completed in this examination. They inferred that there was essentialness contrast at P≤0.05 level on the surface of natural product put away in ZECC at 16°Cand HHF at 8°C and control test (CTS) at 29°C. The distinction was not for the most part because of the capacity innovation.

Methodology

According to a survey of rural areas and cities, farmers and retailers are facing problems regarding the storage of vegetables and fruits. The objective of the paper is to make a natural cooling chamber to store the products below ambient temperature. The farmers having maximum production rates so we have to decide the proper method to construct the cooling chamber. There are lots of methods are used to store the products but we choose the evaporative cooling which is an energy-free method and prevent the product. Select the area and decide proper dimensions, area according to production rate. Finalize all the dimensions and make a design by using CAD-CAM software (Figures 3 and 4). The area or plot is in the direction of the south face because the sun rays are not directly incident on our system. After selecting proper areas bring the construction material like Standard bricks, cement, mud, cow dung, riverbed sand, jute, dry grass, bamboos, and other construction material, etc. Check the water availability and start the construction by plotting all dimensions of the selected area (Figure 5).

During construction make a cavity and fill it by riverbed sand, dry grass, small pieces of bricks, and supply water. After all the construction store the vegetables and fruits in the chamber. Supply the water throughout the cavity and take readings, collect all the data for temperature and humidity.

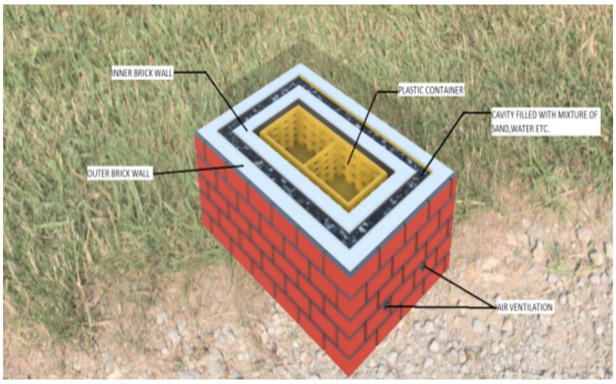

Figure 3.Overall 3D Design

Figure 4.3D Design with Shade

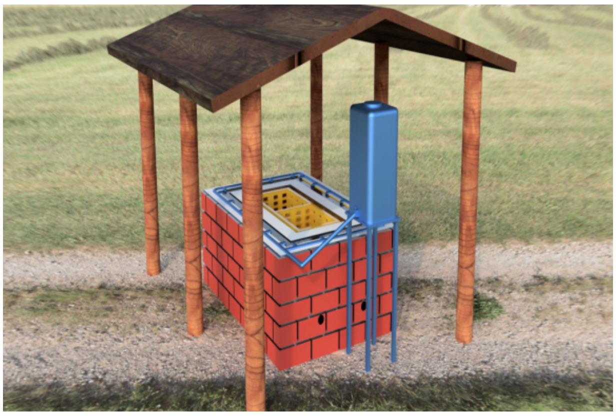

Figure 5.3D Design of water supply System

Materials Required and Construction

The natural cooling chamber is easy to construct, for construction firstly choose the material. Choose proper material that is easily available in rural areas, cities, and is economical for framers and retailers. Collect Indian standard bricks for walls, cement for binding the bricks, riverbed sand, jute, bamboos, and dry grass (Figures 6, 7 and 8). Table 3 shows all material and their quantities.

Table 3.Materials and their quantity

S. No.	Materials	Quantity
1.	Indian Standard Bricks	150
2.	Simple Cement	30–35 kg
3.	Riverbed Sand	20–30 PIP
4.	Dry Grass	2 kg
5.	Bamboo	12
6.	Green Polythene	1

Figure 6.Indian Standard Bricks

Figure 7.River Bed Sand

Figure 8.Cement

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After collection of all the materials start the construction as per decided design and dimensions. Plot the entire dimension on selected area and according to that start to construct the natural cooling chamber. According to design, a chart was prepared for construction which involves inner wall, outer wall, height, and cavity dimensions. Various models of the cooling chamber were studied and the overall dimensions of the natural cooling chamber were decided. We decided to make a chamber for storage capacity of up to 60 kg (Figure 9). Firstly, construct a floor of 40 bricks and fill the gaps by pouring the mixture of cement, sand, and water. Above the floor construct the inner wall as per dimension and after that create a gap of 7.5 cm from the inner wall and construct the outer wall. Fill up the cavity by riverbed sand, small parts of bricks, dry grass, and fill other materials which are having water holding capacity. Take a water tank or can which contain atleast 20–40 liters of water. This tank should be placed near the cooling chamber at a specific height. Attach the pipe to the tank and take a pipe which has small holes and attach to the tank pipe. The pipe, having small holes, is circulated over on cavity. The water was supplied daily because this system is working on the principle of evaporative cooling where water plays a significant role in the natural cooling chamber. The chamber is having storage capacity of up to 60–80 kg and the vegetables and fruits can be stored either in the polythene bags or plastic crates. A temperature indicator was inserted in the cooling chamber to observe the changes and also to check the humidity. It is constructed in such a way that it provides big holes throughout the outer and inner wall to maintain the humidity inside the chamber and circulate fresh air. Table 4 shows details of dimensions and construction.

Table 4.Construction details and dimensions

S. No.	Parameters	Dimensions
1.	Inner Wall	(2.5×1.5 ft)
2.	Outer Wall	(3.5×2.5 ft)
3.	Height	(1.2 ft)
4.	Cavity	(7.5 cm)
5.	Area	(4×3 ft)

The natural cooling chamber is working on the principle of evaporative cooling. Evaporative cooling is a natural process to maintain coolness in the environment without any energy source. The evaporative cooling is defined as when we supply the water to our system then the water absorbs the sensible heat from the atmosphere and water can convert it into latent heat and produce the cooling effect naturally. Vegetables and fruits are stored inside the chamber and water is supplied till al lthecavities are filled. Check outer and inner temperature daily and collect data and represent it in tabular form the temperature decreases up to 10°C–15°C below ambient temperature. We check the temperature for weekly 7 working days during February and March. Here we maintain the humidity of about 95% so; the vegetables and fruits are preserved and maintained its freshness, parameters, etc. We design the cooling chamber for a capacity of 60 kg. The cost of the construction and material is up to Rs. 3000 and the total cost we required is Rs. 5000. So, for a small range, the cooling chamber is economical and easy to construct.

Figure 9.Constructed Model

Figure 10.Stored Vegetables and Fruits

Working and Principle

The natural cooling chamber is working on the principle of evaporative cooling. A cooling chamber was constructed under a shady region and vegetables and fruits were stored in it in plastic crates and polythene. Testing was done by storing tomato, coriander, mint, and apples (Figure 10). After storing vegetables and fruits, the water tank nob was opened and it was ensured that water was supplied throughout the cavities. Water was supplied 2–3 times into the system. Two holes were provided to circulate fresh air inside the chamber and this helped in maintaining up to 95% relative humidity inside the chamber. Since the experiment was carried out in summer, more water was required. Water absorbed heat from the surface and surroundings and after evaporation provides cooling to the vegetables and fruits present in the chamber. Thermocouple and IoT based systems were used for checking the temperature and humidity level. The temperature inside the chamber was maintained between 16°C–23°C. The temperature and

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humidity level was recorded daily. Also, the taste, odour, colour, and appearance of the stored items were checked at regular intervals. All the obtained data were tabulated and comparison was made between the temperatures during February and March and the results were plotted in the graphs for a better understanding.

Observations and Graphs

The natural cooling chamber is having an ambient temperature (T2) below 10°C–15°C. The weekly temperature was recorded in February and March (Table 5). Inside temperature (T1) and ambient temperature (T2) were recorded in °C and the mean temperature was calculated for 4 weeks. The formula for calculate the mean temperature is where, i1 to i7 is the inside temperatures of 7 days in one week, and a1 to a7 are the ambient temperatures of 7 days in one week. Calculated data is represented in tabular form. Stored items were checked at the end of every week for the parameters like taste, odour, appearance, and colour, and ratings were given as 5 (Excellent), 4 (Very Good), 3 (Good), 2 (Fair), and 1 (Poor) (Table 6). Humidity is also the main parameter that needs to be checked at regular intervals and maintained.

Table 5.Temperature in Months of February and March

Month	February							
	Week-1		Week-2		Week-3		Week-4	
Mean Temperature (°C)	Inside (T1)	Ambient (T2)	Inside (T1)	Ambient (T2)	Inside (T1)	Ambient (T2)	Inside (T1)	Ambient (T2)
	20	33	19.6	33	19	34	19.2	34.6
Month	March							
	Week-1		Week-2					
Mean Temperature (°C)	Inside (T1)	Ambient (T2)	Inside (T1)	Ambient (T2)				
	20	33	19.6	33				

Table 6.Parameters Chart

S. No.	Parameters	February				March	
		Week-1	Week-2	Week-3	Week-4	Week-1	Week-2
1	Colour	5	4	3	3	5	5
2	Smell	5	4	4	4	4	4
3	Appearance	4	5	4	4	3	3
4	Taste	5	4	4	3	3	2

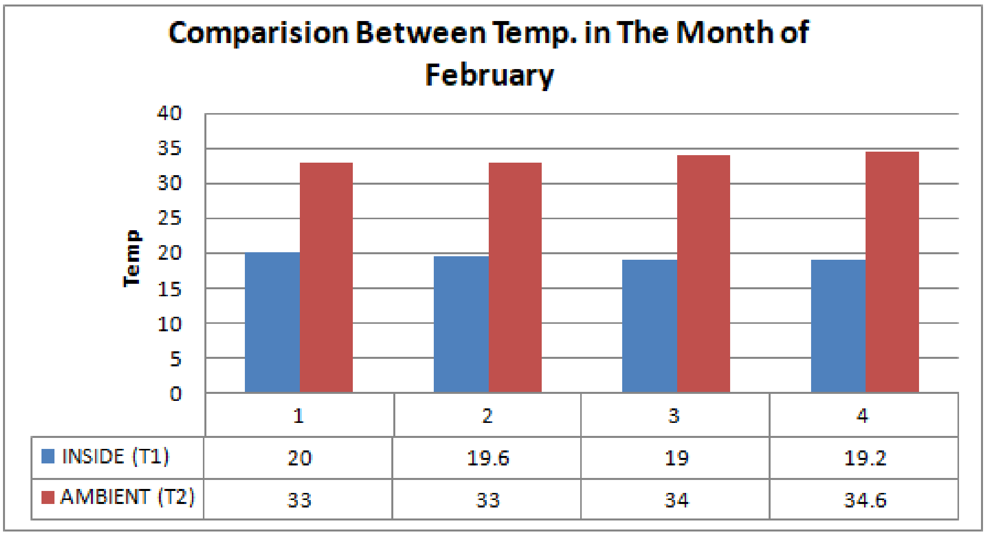

Figure 11.Comparison between temperatures in the month of February

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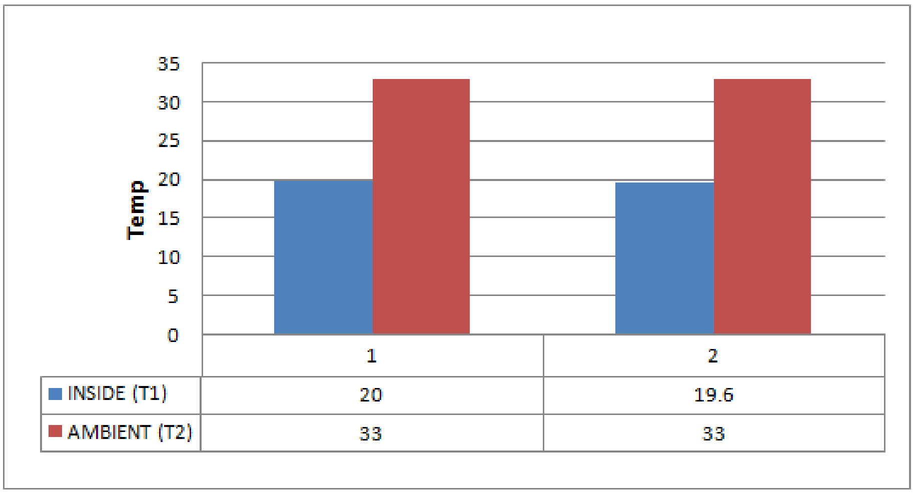

Figure 12.Comparison between temperatures in the month of March

The above Figures 11 and 12show the weekly comparison between temperaturesin the months of February and March.

Result

Table 5 shows the mean temperature of inside and ambient temperature values in February and March. Table 6 shows the parameters of the product stored inside the chamber.

To draw the above figures were taken from Tables 5 and 6. Figure 11 shows a comparison between mean temperatures within the weeks of February and according to this figure, it is clear that the temperature inside the chamber is lower than the ambient one. Also, we calculated the mean temperatures within two weeks of the March, thus Figure 12 shows that the inside temperature in March is also lower than ambient temperature..

Discussion

From the results, it is clear that the temperature inside the natural cooling chamber is 10°C–15°C less than that of ambient temperature i.e. up 16°C–23°C respectively and hence it helps to maintain the freshness and healthiness of the vegetables and fruits.

Conclusion

To maintain the freshness and not to reduce the physiological loss in the weight of the fruits and vegetables, the temperature inside the chamber is maintained in the range of 10°C–15°C below ambient temperature. This temperature can be achieved by a natural cooling chamber. Also, it increases the shelf life of fruits and vegetables which would solve the biggest problem of farmers and retailers. This chamber is built by materials that are easily available across the cities and villages. Less maintenance, no need for electricity, good efficiency, no complex handling system, no electronic control unit, etc. makes this product more reliable for the farmers and the workers. This chamber overcomes all the problems regarding the preservation of fruits and vegetables in a natural way.

Future Scope

The world is going towards innovation and new technologies, due to that, the energy demand are increasing day by day. People need good and healthy food for a living. But the rural areas have remained undeveloped because of many reasons. To overcome the storage of vegetables and fruits problem we have developed a prototype of natural cooling chamber that does not require any type of energy.

In the future, we will develop a natural cooling chamber for a large capacity of about 1000 kg by doing vertical engineering i.e. trying to make cooling chambers one over the other, which will also solve the problem of space. For better air circulation, exhaust fans can be provided which operate on solar energy. Different models made of different materials can also be constructed and tested to reduce the cost and make it more economical for the low-income farmers.

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