I INTRODUCTION

Sprouting is the natural germination process by which seeds or spores put out shoots, plants produce new leaves or buds, or other newly developing parts experience further growth.

The health benefits of sprouts make up quite an impressive list, and they include the ability to improve the digestive process, boost the metabolism, increase enzymatic activity throughout the body, prevent anemia, aid in weight loss, lower cholesterol, reduce blood pressure, prevent neural tube defects in infants, boost skin health, improve vision, support the immune system, and increase usable energy reserves.

There are two types of common bean sprouts:

- Mung bean sprout is made from the greenish-capped mung beans
- Soybean sprout is made from the yellow, large-grained soybean

It typically takes one week for them to become fully grown. The sprouted beans are more nutritious than the original beans and they require much less cooking time.

Other common sprouts used as food include:

- Pulses (legumes; pea family):
    - pea, chickpea, mung bean and soybean (bean sprouts).
- Cereals:
    - oat, wheat, maize (corn), rice.
- Oilseeds:
    - sunflower, linseed, and peanut.

The germination process

Sprouts are rinsed two to four times a day, depending on the climate and the type of seed, to provide them with moisture and prevent them from souring. Each seed has its own ideal sprouting time. After three to five days the sprouts will have grown to 5 to 8

centimetres (2 to 3 in) in length and will be suitable for consumption. If left longer they will begin to develop leaves, and are then known as baby greens. A popular baby green is a sunflower after 7–10 days. Refrigeration can be used as needed to slow or halt the growth process of any sprout.

Common causes for sprouts becoming inedible:

- Seeds are not rinsed well enough before soaking
- Seeds are left in standing water after the initial soaking
- Seeds are allowed to dry out
- Temperature is too high or too low
- Dirty equipment
- Insufficient air flow
- Contaminated water source
- Poor germination rate

II Review of literature

Chavan and Kadam (1989) concluded that "The desirable nutritional changes that occur during sprouting are mainly due to the breakdown of complex compounds into a more simple form, transformation into essential constituents and breakdown of nutritionally undesirable constituents. This is a reason why sprouts are also called pre-digested foods. The metabolic activity of resting seeds increases as soon as they are hydrated during soaking. Complex biochemical changes occur during hydration and subsequent sprouting. The reserve chemical constituents, such as protein, starch and lipids, are broken down by enzymes into simple compounds that are used to make new compounds.

Gillespie (2018) Styrofoam is made mostly of air, meaning it is a poor conductor of heat, but an excellent convector. It traps the air in small pockets, blocking the flow of heat energy. This reduces both conduction and convection and makes Styrofoam a good insulator. On the other hand, conductors such as metal are poor insulators because energy flows through them. Glass and air are other examples of good insulators. Styrofoam is placed in wall cavities to keep the inside of buildings warm. It traps air and reduces the transfer of heat energy, keeping heat inside the building.

III. Work Accomplishment

3.1Problem Definition –

There was a problem of sprouting for grains and seeds such as mataki, cow peas and chhole in VA kitchen particularly in winter season because, the required temperature for sprouting is 30 ˚C that was unable to maintain. Another problem was the bulk of seeds i.e cowpeas get sticky during soaking process and there was presence of foul smell.

Figure 1.Previous prototype

3.2Objective –

1. To optimize the various conditions for sprouting such as temperature, humidity and oxygen
2. To work on less time consuming system.

3.3Trial 1

1. The first trial was taken on mataki to determine its actual soaking time.
2. In this trial a 20 gram mataki was soaked in 100 ml water having the temperature 19 - 21 ˚C.
3. The experiment was carried out at room temperature 20 - 23 ˚C.
4. To maintain the temperature mataki was kept in thermocol box.

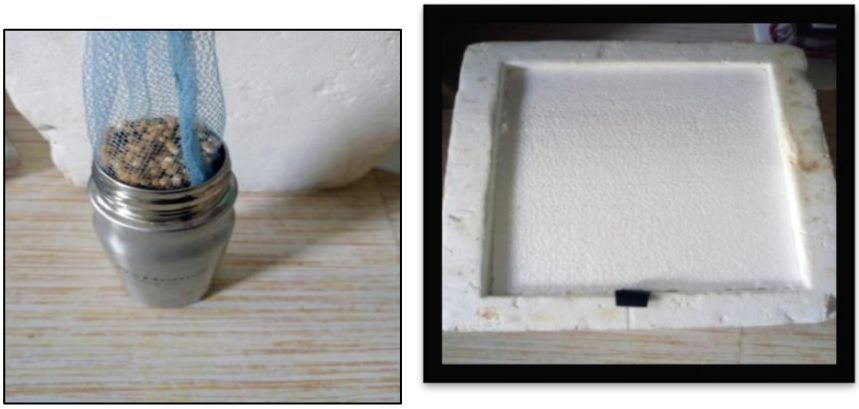
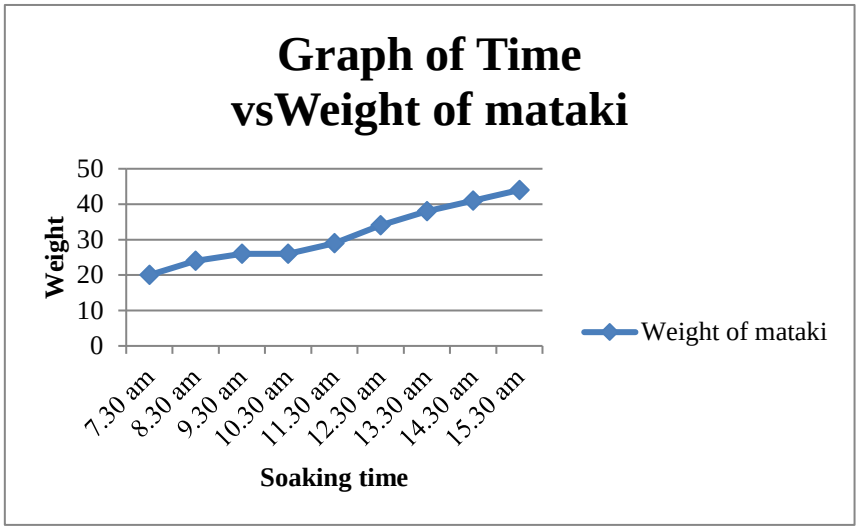


Figure 2.Thermocol box used for maintain the temperature.

From above trial the following data reading of soaking time were taken:

Table-1; Soaking time and weight of mataki

Soaking Time	Weight of mataki(gram)
7.30 am	20
8.30 am	24
9.30 am	26
10.30 am	26
11.30 am	29
12.30 am	34
13.30 am	38
14.30 am	41
15.30 am	44



Result -

1. Final weight of mataki is 48 gram.
2. Soaking time for mataki is 8 hr.

Conclusion-

1. From above trial it was concluded that actual soaking time of mataki 8 hr.

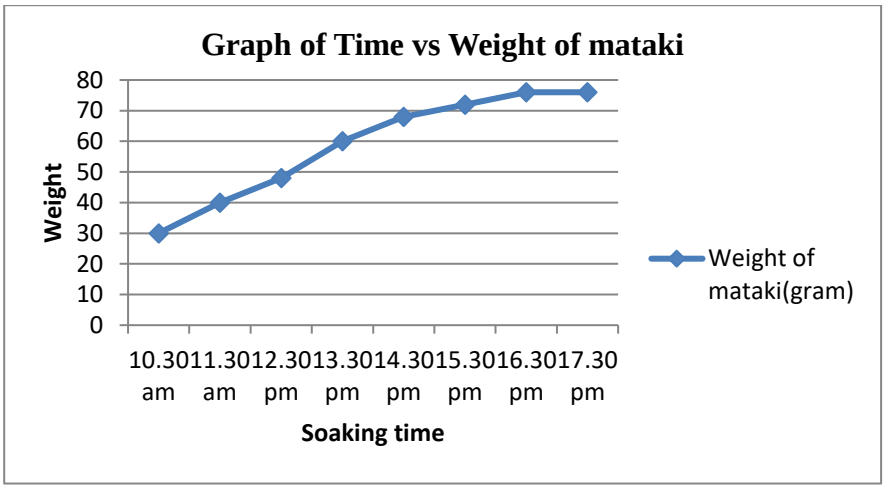
3.4Trial 2

1. The second trial was conducted on mataki to check soaking time by varying the temperature of water
2. In this trial a 30 gram mataki was soaked in 200 ml water having the temperature 30 - 35 ˚C.
3. The experiment was carried out at room temperature 20 - 23 ˚C.

From above trial the following data reading of soaking time were taken:

Table 1.Soaking time and weight of mataki

Soaking time	Weight of mataki(gram)
10.30 am	30
11.30 am	40
12.30 pm	48
13.30 pm	60
14.30 pm	68
15.30 pm	72
16.30 pm	76
17.30 pm	76



Result -

1. Final weight of mataki is 88 gram.
2. Soaking time for mataki is 8 hr.

Conclusion –

1. It was conclude that there was no reduction in soaking time of mataki.
2. There was no effect of increased in temperature of water on soaking time of mataki.

To recheck the above results, water holding capacity of mataki was calculated:

$$\textbf{Water holding capacity} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Final weight}} \times 100$$

$$= \frac{243 - 100}{243]} \times 100$$

$$= 58.8\%$$

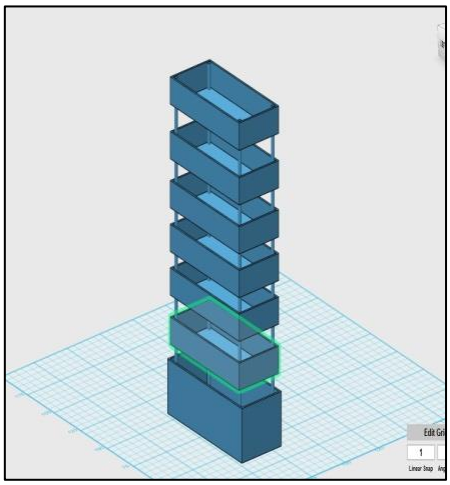
From above calculation and second trial it was conclude that water holding capacity of mataki is up to 58% even varying the amount weight of mataki for trial.

3.5Modification in existing structure

1. After getting water holding capacity of mataki it was decided to take the actual trial of mataki in structure with optimized conditions.
2. First measured the dimensions of already available structure of sprouter in VA.
3. The foam sheet were taken and cut into the proper dimensions with the help of zic saw.
4. T shaped hooks were made from M.S. rod with the help of spot welding and the foam sheets were attached to the all sides of structure. The door of structure was made by polythene paper.
5. Then the six trays of size were kept inside the structure on the horizontally situated PVC pipe. Another tray of size was kept at the bottom of the structure to keep the water for sprinkling on the seeds.
6. Also submersible pump of 2.8 M maximum head, 3000 LPH maximum discharge, power of 40 watt was fitted in the structure. The bubbler is provided

to give the continuous supply of oxygen to the water in the bottom tray of structure.

7. Two mini sprinklers were attached at the center of the lateral according to the position of the tray for that radius of using sprinkler was measured for equal distribution of water. Separate lateral line with two sprinklers was given to each tray.



3.6Material used for structure;

Sr. No.	Particulars	Dimensions and specification	Quantity	Rate per unit	Cost(Rs)
1	U-PVC pipe structure	109cm×56cm	1		366.68
2	Pump	18 Watts	1	400	400
3	Foggers	-	12	5	60

4	Bubbler	2.5 Watts	1	150	150
5	Plastic tray	47.8cm×34cm×8cm	6	100	600
6	Foam sheet	76.25cm×76.25cm	3	300	900
Total					=2476.68

The next trial was taken in above modified structure.

Trial 3(Trial in prototype)

1. 100 gram mataki was taken and as it is kept inside the structure from 7.00 am to 9.00 am (next day) without soaking.
2. The inside temperature of structure was 27˚C.
3. 5min/ hr water sprayed on the mataki. For first 12 hrs. by setting of the timer.

Figure 3.100 gram mataki

Figure 4.after 26 hr.

Results:

1. Final weight of mataki after sprouting is 334 gram.
2. Time required for sprouting of mataki is 26 hr.

Conclusion –

1. It was observed that there is accumulation of water in the mataki at the center of the tray.
2. After 26 hr we get sprout for mataki but there is requirement to minimize the time of sprouting.

3. So we decided to give the less water to mataki as compare to trial 3 and next trial was taken.

Trial 4

1. 100 gram mataki was taken and as it is kept inside the structure from 7.00 am to 9.00 am (next day) without soaking.
2. The inside temperature of structure was 27˚C.
3. 6 sec/ hr water sprayed on the mataki for first 9 hrs. by setting of the timer.

Figure 5.100 gram of mataki

Figure 6. After 20 hr

Result -

1. Final weight of mataki after sprouting is 334 gram.
2. Time required for sprouting of mataki is 20 hr.

Conclusion –

1. After 20 hr we get sprout for mataki which is less than trial 3.
2. In this trial it is seen that water is not sprayed on all mataki in 6 sec/hr.
3. So we decided to give the more water to mataki as compare to trial 4 and next trial was taken.

Trial 5

1. 600 gram mataki was taken and as it is kept inside the structure from 11.00 am to 9.00 am (next day) without soaking.
2. The inside temperature of structure was 30˚C.
3. 10 sec/ hr water sprayed on the mataki. for first 12 hrs. by setting of the timer.

Figure 10.100 gram weight of mataki

Figure 11.After sprouts 22 hr.

Result -

1. Final weight of mataki after 22 hr is 1590 gram.
2. Time required for sprouting of mataki is 22 hr.

Conclusion -

1. In this trial it is seen that water is sprayed on all mataki in 10sec/hr.
2. After 22 hr we get sprout for mataki time which is more than trial 4.
3. It was observed that there is accumulation of water in the mataki at the center of the tray.

Trial 6 –

1. 800 gram mataki was taken and as it is kept inside the structure from 11.00 am to 9.00 am (next day) without soaking.
2. The inside temperature of structure was 29˚C.
3. 6 sec/ hr water sprayed on the mataki for first 8 hrs. by setting of the timer.

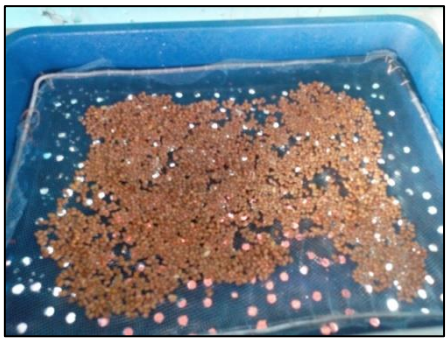


Figure 7.100 gram of mataki.

Figure 13.After 22 hr

Result -

1. Final weight of mataki after sprouting 22 hr is 1886 gram.
2. Time required for sprouting of mataki is 22 hr.

Conclusion –

1. In this trial works well for large quantity of mataki.

Trial 7 –

1. 254 gram mataki was taken for one tray and as it is kept inside the structure from 11.00 am to 11.00 am (next day) without soaking.
2. The inside temperature of structure was 30˚C.
3. 6 sec/ hr water sprayed on the mataki for first 8 hrs. by setting of the timer.

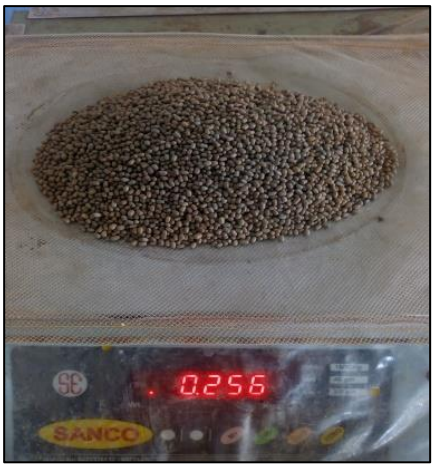


Figure 13.256 gram of mataki **Figure 14 after 24 hr**

Result -

1. Final weight of mataki after sprouting is 484 gram.
2. Time required for sprouting of mataki is 24 hr.

Conclusion -

1. In this trial it was seen that 250 gram of mataki well sprouted for one tray.

Trial 8

1. 200 grams of cowpeas were taken and it was kept inside the structure from 12.00 pm to 8.00 am (next day) without soaking.
2. The inside temperature of structure was 31˚C.
3. 6 sec/ hr water sprayed on the cowpeas for first 9 hrs. by setting of the timer.

Figure 8.100 gram cowpeas **Figure 9.after 22 hr**

Result -

1. Final weight of cowpeas after sprouting is 514 gram.
2. Time required for sprouting of cowpeas is 22 hr.

Conclusion –

1. In above trial it was seen that cowpeas had no foul smell but they were sticky.

Trial 9

1. 200 grams of cowpeas were taken and it was kept inside the structure from 12.00 pm to 10.00 am (next day) without soaking.
2. The inside temperature of structure was 31˚C.
3. 6 sec/ hr water sprayed on the cowpeas for first 8 hrs. by setting of the timer.

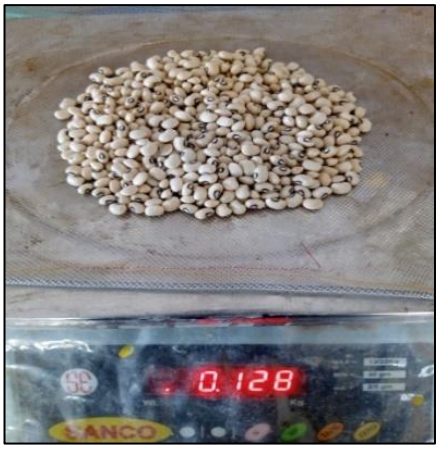


Figure 10.128 gram cowpeas **Figure 11.after 22 hr.**

Result -

1. Final weight of cowpeas after sprouting is 200 gram.
2. Time required for sprouting of cowpeas is 22 hr.

Conclusion –

1. In above trial it was seen that cowpeas had no foul smell and they no sticky form.
2. This system works well for cowpeas.

Trial 10

1. 250 grams of cowpeas (hybrid variety) were taken and it was kept inside the structure from 11.00 pm to 11.00 am (next day) without soaking.
2. The inside temperature of structure was 30˚C.
3. 6 sec/ hr water sprayed on the cowpeas for first 8 hrs. by setting of the timer.

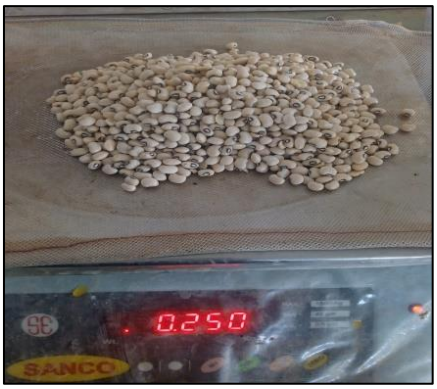


Figure 12.250 gram of cowpeas **Figure 13.After 24 hr**

Result –

1. In this trial after 24 hr cowpeas was no sprout form.

Conclusion –

1. In above trial it was seen that cowpeas (hybrid verity) had no proper sprouts with foul smell and sticky form.
2. This system not works well for cowpeas.

Trial 11

1. 140 grams of chhole were taken and it was kept inside the structure from 11.00 pm to 4.00 pm (next day) without soaking.
2. The inside temperature of structure was 30˚C.
3. 10 sec/ hr water sprayed on the chhole for first 8 hrs. by setting of the timer.

Figure 14.140 gram of chhole

Figure 15.After 29 hr.

Result –

1. In this trial after 29 hr chhole was no sprout form.

Conclusion –

1. In above trial it was seen that chhole had no proper sprouts with foul smell and sticky form.
2. This system not works well for chhole.

Trial 12

1. 256 grams of chhole were taken and it was kept inside the structure from 11.00 pm to 4.00 pm (next day) without soaking.
2. The inside temperature of structure was 30˚C.
3. 10 sec/ hr water sprayed on the chhole for first 8 hrs. by setting of the timer.

Figure 16.256 gram of chhole **Figure 17.After 24 hr**

Result –

1. In this trial after 24 hr chhole was no sprout form.

Conclusion –

1. In above trial it was seen that chhole had no proper sprouts with foul smell and sticky form.
2. This system not works well for large quantity of chhole.

Trial 13

1. 102 grams of chickpeas were taken and it was kept inside the structure from 11.00 pm to 4.00 pm (next day) without soaking.
2. The inside temperature of structure was 30˚C.
3. 10 sec/ hr water sprayed on the chickpeas for first 12 hrs. by setting of the timer.

Figure 18.102 gram of chickpeas **Figure19.After 29 hr.**

Result -

1. Final weight of chickpeas after sprouting is 204 gram.
2. Time required for sprouting of chickpeas is 29 hr.

Conclusion –

1. In above trial it was seen that chickpeas had no foul smell and they no sticky form.
2. This system works well for chickpeas.

Trial 14

1. 124 grams of peas were taken and it was kept inside the structure from 11.00 pm to 4.00 pm (next day) without soaking.
2. The inside temperature of structure was 30˚C.
3. 10 sec/ hr water sprayed on the cowpeas for first 12 hrs. by setting of the timer.

Figure 20.124 gram of peas **Figure 21.After 29 hr.**

Result -

1. Final weight of peas after sprouting is 264 gram.
2. Time required for sprouting of peas is 29 hr.

Conclusion –

1. In above trial it was seen that peas had no foul smell and they no sticky form.
2. This system works well for peas.

Trial 14

1. 1 kg of finger millet was taken and it was kept inside the structure from 11.00 pm to 7.00 pm (next day) without soaking.
2. The inside temperature of structure was 30˚C.
3. 10 sec/ hr water sprayed on the finger millet for first 10 hrs. by setting of the timer.

Figure 27.1kg of finger millet **Figure 28. After 32 hr**

Result -

1. Final weight of finger millet after sprouting is 1710 gram.
2. Time required for sprouting of finger millet is 32 hr.

Conclusion –

1. In above trial it was seen that finger millet had no foul smell and they no sticky form.
2. This system works well for finger millet.

3.7Overall conclusion from above all trials;

- The prototype of sprouter worked well without for all except chhole where not proper sprouting observed and also the foul smell and stickiness was observed.
- This system works well for large quantity (about 1.5kg) of all seed.

3.7.1Soaking period and quantity of water for grains -

Sr.no	Name of grains	Soaking time(hr)	Water quantity(ml)	SproutesTime
1	Mataki	8	680	20
2	Cowpeas	8	680	22
3	Chhole	12	1020	29
4	Chickpeas	12	1020	29
5	Peas	12	1020	29
6	Finger millet	10	850	32