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Effect of pyramids on microorganisms

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Investigations have been undertaken to find out if an enclosed pyramidal structure has any influence on the growth of microorganisms inside them, as claimed in legendary literature. Five models were used, four of them being pyramidal in shape and the fifth with a flat roof. The medium chosen was fresh unboiled milk. The control was the same milk sample kept in the open. Results subjected to statistical analysis indicate that there is a noticeable influence of the pyramidal shape on the rate of growth of microorganisms. Quantitative data have been supported by visual observations.

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Pyramids are structures usually with a square base and sloping triangular sides meeting in an apex. Even though they are normally associated with the Egyptian culture, they are to be found in almost all ancient cultures. The stepped pyramids of the Mayan culture of South America are well known. One can find pyramidal structures mentioned even in the ancient *Vedic* culture as part of *Vaastu Shastra*. The canopy of the sanctum sanctorum in Indian temples is an example of the use of a pyramidal structure.

Lots of legends have grown around the purpose of the pyramids, especially of the Egyptian variety. Many claims are made about the influence of pyramids on both living and non-living matter. There are claims that perishable substances placed inside pyramidal structures are preserved for long periods. This is attributed to the property of pyramids of capturing cosmic energy from the surroundings, which is supposed to inhibit the growth of microorganisms, arresting or retarding the decay process.

While these claims are part of a cultural heritage, there are no records available about systematic scientific controlled experiments done to substantiate these claims. The claims also cannot be dismissed offhand as superstition, since they are the accumulated wisdom of several millennia. Hence they deserve serious consideration. It was therefore decided to undertake an experimental investigation, using standard experimental techniques, subjecting the results to a rigorous statistical analysis, but focusing the attention here on only one aspect of the problem, viz. the effect of the structure on the growth of microorganisms in samples of fresh milk placed inside pyramidal structures.

There is a vast popular literature available on Egyptian pyramids, about the Pharaohs who built them, how they came to be opened up, etc. They are considered one of the Seven Wonders of the World. However, literature about the scientific aspects of pyramids is scanty. It is only recently that attempts have been made to investigate these peripheral aspects[1]. In a recent publication, researchers have tried to draw parallels between Egyptian pyramids and Indian temple architecture[2], the latter being based on the principles of *Vaastu Shastra*.[3] The Indian science of *Vaastu* traces its origins to the *Atharvaveda*, which is now considered to be at least as old as 2500 BC, according to the latest discoveries of the Sarasvati Valley Civilization[4].

The theory of creation of the universe, according to the *Vedic* thought, recognises five primordial elements, known as the *Panca Mahabhutas*. These are Space, Wind, Fire, Water and Earth. Of these, Space is the subtlest and is the repository of all cosmic energy. It is the source for the other elements and hence occupies a preeminent place in Creation. It is limitless, without boundaries, in the absence of which nothing else can exist. It is this thought which has played an important role in defining the principles of *Vaastu*.

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Pyramids are considered to represent this space element in ancient architecture. They came into prominence in Indian culture with the design and construction of temples. Practically every temple built on traditional lines has a pyramidal structure over the sanctum sanctorum. This structure makes use of geometrical shapes, such as domes, trapezoids, etc. It was the belief in ancient times that these geometrical shapes, representing space in miniature, help in trapping cosmic energy from outer space and thus impart divinity to the idols installed at their epicenter or at the base below the apex. This could also be the thought behind the Egyptian pyramids, that the cosmic energy would keep the souls of the mummies intact until the day when they would return from the land of the dead.

How far are these claims true? This is a question which has been bothering Egyptologists for several centuries. These claims have contributed in a substantial measure to the legends associated with the pyramids, bordering almost on superstition. The same could be said of the claims of Va*astu Shastra*. However, very recently, some publications have appeared about studies on pyramids, especially about their astronomical significance[5,6]. This is a welcome sign that some serious investigations are going on in this field.

Where it concerns claims of *Vaastu Shastra*, the situation is different. There are hardly any investigations, which have found a place in scientific journals. It is to fill this lacuna that the current investigation was undertaken on strictly scientific lines to study one aspect of the problem, viz, whether pyramids have any influence on the growth of microorganisms.

Methodology

The objective of this research was basically to place samples of fresh milk inside pyramidal structures and to compare their condition with a control milk sample kept outside. The following five types of pyramids were chosen for the experiments-a plywood rectangular pyramid (PWR) with a square base of length 171 mm and height 152 mm: a plywood pyramid (PWP) with a square base of 241 mm and height 152 mm: a fiberglass pyramid (FGP1) with a square base of 241 mm and height of 152 mm: a fiberglass pyramid (FGP2) of square base 273 mm and height of 178 mm and a fiberglass octagonal pyramid (FGO) with an octagonal base of length 114 mm and height 190 mm. Line drawings of these pyramids with plan and elevation views are shown in Fig. 1.

The reason for selecting the above shapes and sizes was to enable the comparative study with respect to the material used, the configuration of the base as well as the shape itself. The space volumes of PWR, PWP and FGP1 were the same i.e. 0.0045 cm, whereas those of FGP2 and FGO were slightly more i.e. 0.0075 cm and 0.0056 cm, respectively.

The experiments were conducted on fresh cow's milk. The milk was procured from the diary-farm attached to the campus where the experiments were done. Fresh unboiled milk was used, the same sample being used in the pyramids and as control.

Each of the five pyramids was kept in an individual room, the sixth room being used as control. All rooms were identical in size, measuring 1.2 m×2.2 m. Before the start of each trial, all six rooms were fumigated to remove any airborne organisms. The fumigation was done by placing 4 gm of potassium permanganate in a petridish and adding 1 ml of formaldehyde solution. To make the fumigation more effective, all the doors and windows were kept closed for 24 hrs before the start of the experiment.

The pyramids were placed in the rooms with one of the sides being oriented in the magnetic North-South direction. The milk samples, all measuring 50 ml, were kept in plastic beakers on the floor of the pyramids, exactly below the apex. Before the start of the experiment, lactometer readings of the milk samples were determined to ascertain the fat content.

The duration of the experiment was 7 days. The following data were collected everyday from the samples from all the six rooms: pH value, odour, colour, state of the sample (whether curdled or not) and microorganism count. The volume and fat content were measured on the first and the last day.

Microorganism count was determined by following standard procedures[7]. Two representative fields of the same sample were prepared on glass slides, by spreading one drop evenly on the glass surface. The surface was dried and the sample fixed to the surface by passing the slide over a flame with light heat. The slides were dipped in xylene to remove the fat content and then washed with alcohol. Methylene blue was used for staining. The slide was then washed with distilled water to remove any excess of methylene blue. The counting of microorganisms was done on a field of 1 sq mm. The experiments consisted of three independent trials, each lasting seven days, to generate enough data to make statistical analysis meaningful.

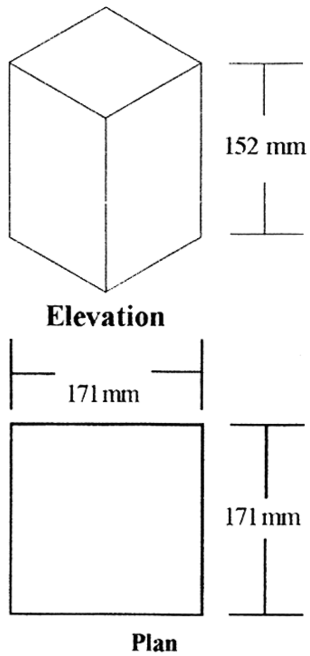

Fig. 1a Plywood Rectangle (PWR)

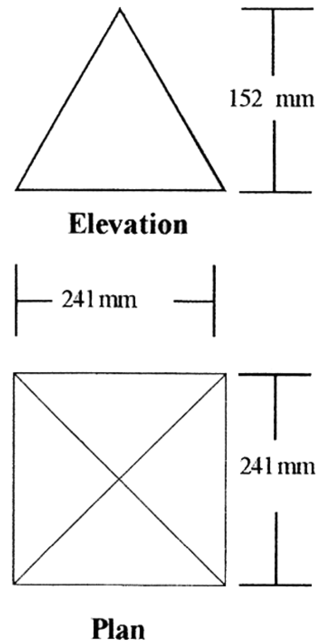

Fig. 1b Plywood Pyramid (PWP)

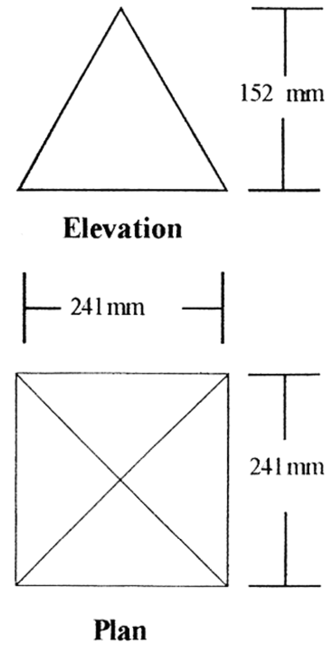

Fig. 1c Fiber Glass Pyramid (FGP1)

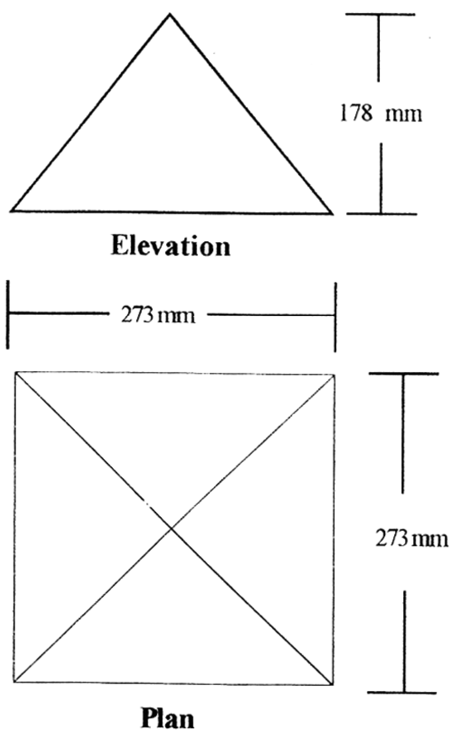

Fig. 1d Fiber Glass Pyramid(FGP2)

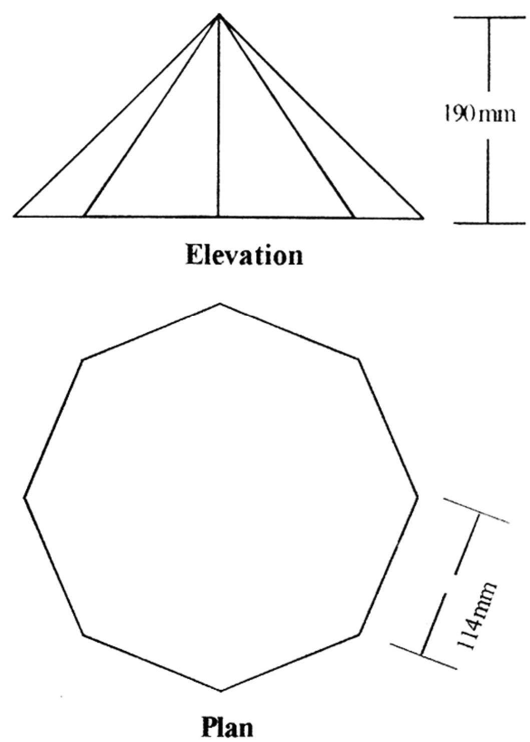

Fig.1e Fiber Glass Octogonal Pyramid (FGO)

Fig. 1. Pyramid Models

Results

The results of the experiments are of two types-qualitative and quantitative. The qualitative part of the results concerns the ascertainment of the color of the sample, its smell, its appearance i.e. whether it is curdling or still fluidic. Even though the observations were made every day, only those relating to the first and the seventh days are presented in Table 1.

The quantitative results relate to the measurement of the pH value of the samples and the growth of microorganisms. These were measured everyday, but the volume and the fat content were measured only on the first and the seventh days. The pH values are indicated in Table 1. The microbial characteristics are presented in Table 2 for all the seven days of the experiment. These include the data for the following microorganisms: *Staphylococci* (s), *Bacillus* (b) and *Corynebacteria* (co). All the values given in these tables are averages taken over three independent trials.

The data were subjected to a rigorous statistical analysis. For all the four types of bacteria, the average for the seven days, the standard deviation and percentage change relative to the control were calculated. To test for significance, Student's *t*-test was resorted to. Table 2 contains all the calculated values, along with the t values.

Part of this data is presented in a graphical form in Figs 2, 3 and 4. These refer respectively to the growth of *Staphylococci, Bacillus* and *Corynebacteria*. The full data with all tables and charts are available[8]. Only a representative sample is given here for purposes of illustration. The statistical analysis was done for the full data and all conclusions have been substantiated by the full data.

Figure 2 shows the rate of growth of *Staphylococci* during the span of 7 days. It is seen that in all cases, except FGP2 and FGO, there is a rapid growth on the first day itself. The growth slows down and becomes steady, the rate of growth becoming constant. The control shows the largest growth, with PWR, PWP and FGP1 showing lower values. The actual count of the microorganism is shown against the experimental points for the sake of convenience. It is also seen that there is no growth at all in the case of FGP2 and FGO.

The same trend is also observed in the case of *Bacillus* (Fig. 3). In this case also, the rate of growth on the first day is very steep, tapering off into a steady growth for all cases except FGP2 and FGO. There is not much variation among control, PWR, PWP and FGP1. Here again, there is hardly any growth in the case of FGP2 and FGO.

In *Corynebacteria*, the data follow the same trend as in the two earlier cases (Fig. 4). The rate of growth on the first day is quite steep for all cases except FGP2 and FGO, gradually tapering off to a steady increase. The variation in the individual values is of the same order as in the case of *Staphylococci*. Again, the data show that the growth is nil for the case of FGP2 and FGO.

One striking feature of this data is that the three microorganisms studied are dormant and do not show any growth in the case of fiberglass pyramids with a square and an octagonal base. This does not necessarily mean that the microorganisms have been destroyed. Only their growth is inhibited. Once the samples are withdrawn from the pyramids they are subject to decay exactly as the control exposed to the atmosphere.

These results were supplemented with visual observations, which have been summarized in Table 1. The visual observations referred to the color, smell and the appearance of the samples observed everyday. However, only the observations for the first and the seventh days are given in the table for the sake of brevity. The pH values are also included in the table for the sake of completeness. Full particulars of all the data and observations are available[8].

Table 2 contains the summary of the bacterial characteristics for all pyramidal structures and the control for all the seven days of the experiment. It also gives the average values and the standard deviations as calculated from the raw data, which were also subjected to Student's t-test for significance.

Discussion

The discussion has been presented in two parts. The physical qualitative results have been taken up first. Table 1, which summarizes all the results, shows that except in the case of FGP2 and FGO, in all other cases, including C, the milk changes cooler. In the case of PWR the sample emits a foul smell and curdles, indicating a rapid growth of microorganisms as in C. So far as PWP and FGP1 are concerned, there is discolouration of the sample, which still retains its milky nature. The best results are obtained from FGP2 and FGO, where the sample still retains its milkiness, sweetness and liquidity.

Even though models PWR and PWP are both of wood, the difference in the behaviour of the milk samples between them shows that the pyramidal shape is more effective than the flat-roofed model. There is speculation that pyramidal shapes are

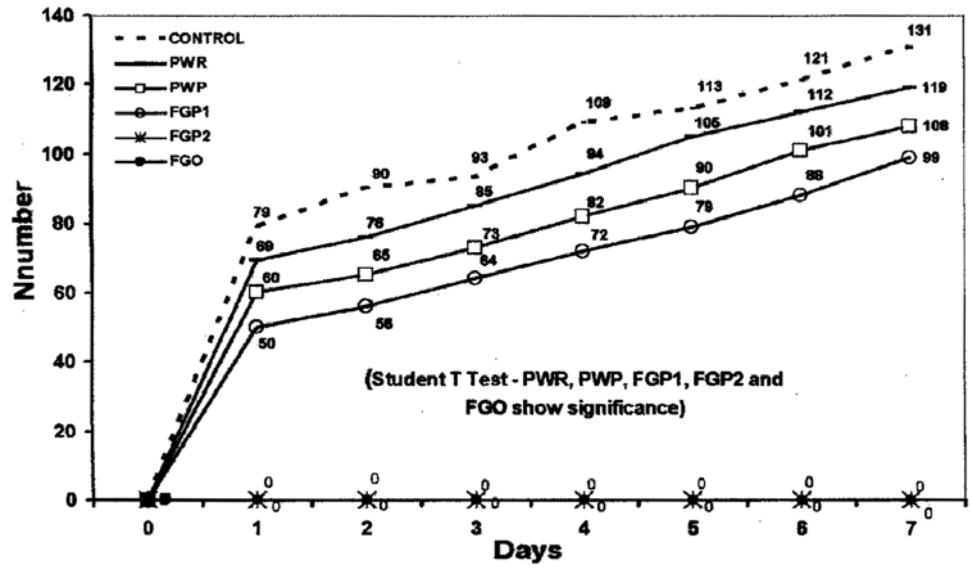

FIG 2. Growth of Microorganism - Staphylococci

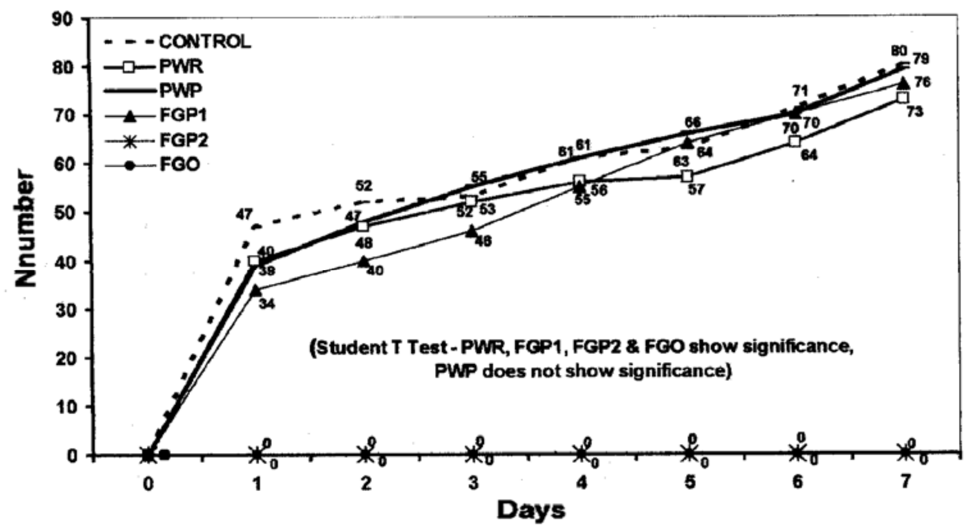

FIG 3. Growth of Microorganism - Bacillus

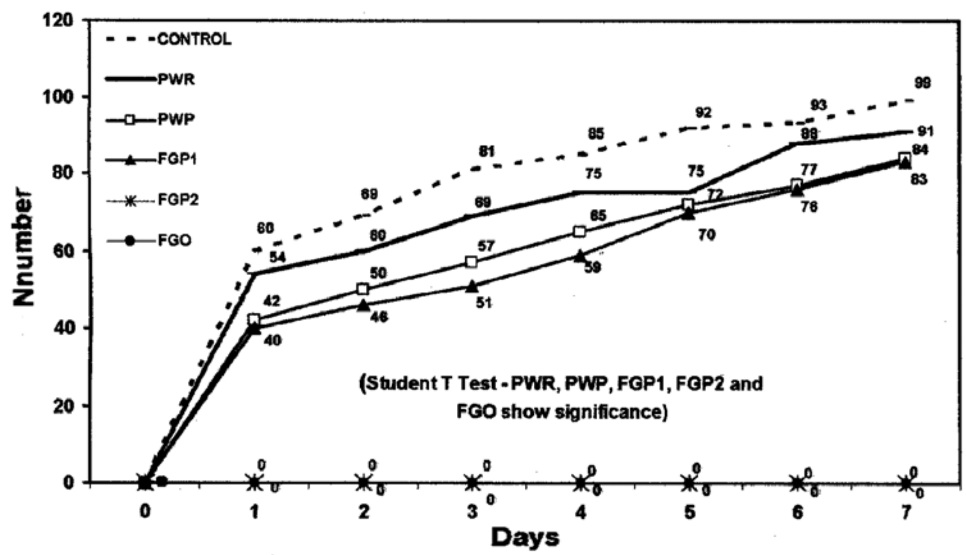

Fig 4. Growth of Microorganism - Corynebacteria

Table 1—Physical characteristics

Model	Particulars							
	Colour		Smell		Appearance		pH	
	Day 1	Day 7	Day 1	Day 7	Day 1	Day 7	Day 1	Day 7
C	top dark yellowish	dark yellowish with grey spot	foulness	foulness	light curdling	heavy curdling	7.00	6.50
PWR	top dark yellowish	dark yellowish with grey spot	foulness	foulness	light curdling	heavy curdling	7.00	6.50
PWP	top light yellowish	top light yellowish	sweetly	sweetly	fluidity	fluidity	7.50	7.25
FGP1	top light yellowish	top light yellowish	sweetly	cheeses	fluidity	fluidity	7.00	6.50
FGP2	milky	milky	sweetly	sweetly	fluidity	fluidity	7.50	7.25
FGO	milky	milky	sweetly	sweetly	fluidity	fluidity	7.50	7.00

Table 2—Bacterial characteristics

Model	B	Day								Ave	Std	*t*-Values
		0	1	2	3	4	5	6	7			
C	s	0	79	90	93	109	113	121	131	105.14	18.52	
	b	0	47	52	53	61	63	71	80	61.00	11.59	
	co	0	60	69	81	85	92	93	99	82.71	13.96	
PWR	s	0	69	76	85	94	105	112	119	94.29	18.71	0.0001
	b	0	40	47	52	56	57	64	73	55.57	10.85	0.0005
	co	0	54	60	69	75	75	88	91	73.14	13.56	0.0008
PWP	s	0	60	65	73	82	90	101	108	82.71	18.03	0.0000
	b	0	39	48	55	61	66	70	79	59.71	13.59	0.3968
	co	0	42	50	57	65	72	77	84	63.86	15.07	0.0000
FGP1	s	0	50	56	64	72	79	88	99	72.57	17.49	0.0000
	b	0	34	40	46	55	64	70	76	55.00	15.78	0.0229
	co	0	40	46	51	59	70	76	83	60.71	16.12	0.0000
FGP2	s	0	0	0	0	0	0	0	0	0	0	0
	b	0	0	0	0	0	0	0	0	0	0	0
	co	0	0	0	0	0	0	0	0	0	0	0
FGO	s	0	0	0	0	0	0	0	0	0	0	0
	b	0	0	0	0	0	0	0	0	0	0	0
	co	0	0	0	0	0	0	0	0	0	0	0

s—*Staphylococci*, b—*Bacillus*, co—*Corynebacteria*,
Ave—average value of the total 7 days and Std—standard deviation.

effective in capturing cosmic radiation, which helps in arresting the growth of microorganisms. However, data to substantiate this is scanty. It will need a more detailed investigation to establish the veracity or otherwise of this speculation.

Models FGP1, FGP2 and FGO are made of fiber-reinforced plastic. However, the latter two show hardly any discolouration of the sample, whereas the former shows noticeable discolouration. The only difference between these models is their size, FGP1 being smaller than FGP2 and FGO.

The most interesting result is that for models FGP2 and FGO, which shows that the samples do not undergo any deterioration at all. These two models are both of fiber-reinforced plastic and both are pyramidal in shape. The only difference between them is that their bases are different, one of them being square and the other octagonal. Also, both of them are larger in volume than the other models used. This naturally leads to the question if there is any optimum size for which the pyramid is most effective. This will require a more detailed investigation before any definite conclusions can be drawn.

In order to decide whether these results are meaningful, a closer look at the quantitative results becomes necessary (Figs 2, 3 and 4). Figure 2 shows the data for *Staphylococci*, Fig. 3 for *Bacillus* and Fig. 4 for *Corynebacteria*. The growth in control is the highest for *Staphylococci* and *Corynebacteria*. The next highest is PWR, followed by PWP and FGP1, which is also the trend seen from the qualitative data. So far as *Bacilli* are concerned, all models except FGP2 and FGO appear to show the same trend.

Just as in the case of the qualitative results, the figures show that there is hardly any bacterial growth in the case of models FGP2 and FGO. Therefore, these two independent observations, qualitative and quantitative, support each other and lead to the conclusion that pyramidal structures do inhibit the growth of microorganisms.

Conclusions

Pyramidal structures exhibited an effect on the growth of microorganisms in milk samples kept inside them. A conical pyramidal structure was found to be more effective than a flat-roofed structure. Wooden structures were not as effective as plastic structures. The size of the structure appeared to have a noticeable influence, leading to the question whether there is any optimal size below which the pyramid is ineffective and above which it becomes effective. More investigations are needed to quantify this effect.

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