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Research Article

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Studies on Pre-Processing Techniques of Coconut and Optimization to Separate Coconut Meat from the Testa

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ABSTRACT

The present research work was done on fresh and matured coconut to separate coconut meat from the testa (brown skin). Pre-processing treatments such as soaking in water, hot water, deep freezing and liquid nitrogen were done to separate coconut meat from its testa. The physical changes were observed for fresh and matured coconut meat with different treatments having assorted timings and constant temperature. The post-processing parameters such as moisture content (%), color (L, a, b), water activity and texture (bio yield; firmness) were studied. The optimization was done based on the isolation of meat with different treatments before and after paring. The results obtained in the post-processing parameters were employed to optimize the separation of coconut meat from the testa. Amongst the two treatments (i.e. deep freezing; liquid nitrogen), four treatments shown desirable paring with constant temperature (^{0}C) and time (hrs). But, the effect of paring was advantageous in the deep freezing (-18 ^{0}C/36 hrs per copra) and (-18 ^{0}C/12 hrs) liquid nitrogen for fresh coconut meat with constant time and temperature. The article finds application in the recent research quest for paring, extraction process of VCO (virgin coconut oil) that could be commercialized in economically conductible manner focusing on the consumer interests on functional value for fiber, fats and oils.

Key words: *Fresh and matured coconut, Deep-freezing, Liquid nitrogen, Temperature, Time.*

INTRODUCTION

Coconut tree (*cocos nucifera* (L.)), family of Arecaceae which was most widespread fruit tree in India. Structurally coconut consists of a flesh and water (endosperm), protected by three sections known exocarp, mesocarp and endocarp. Epicarp and Mesocarp was the outer and the fibrous covering of coconut testa (i.e brown skin) and coconut meat. Basically, there are two types of coconut for getting coconut water. They are unmatured (i.e. green color) and matured (light orange color.

It is structurally consisting of husk, kernel and water varied with maturity of coconut[18].

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Though numerous methods used in India (i.e. traditional and advanced) for coconut de-shelling, the separation of brown skin and coconut meat was labor intensive. The de-husking of coconut and separation of brown skin from coconut meat were regarded as the most tiring, time consuming, crucial operation and in turn involves human drudgery. To overcome this problem, electric power operated coconut deshelling machines was manufactured in earlier times Kumar *et al*.[21]. Manikantan *et al*.[24] coconut testa removing machines was useful in paring out the outer layer, which would contain brown pigments that reduces the product quality.

However, there were numerous application in foods and beverages other than oil extraction. The mesocarp (heavy, tanned and fibrous) was utilized in industries for power generation in boiler. Coconut testa (i.e brown skin), a thin layer covering coconut meat was identified for abundant availability of antioxidants and phytochemicals. Therefore, extracted antioxidants identified for its availability of phenolic acids, flavonoids, tocopherols and scavengers for delaying and prevention of oxidation by trapping free radicals. Though, there were plenty studies on extraction of coconut meat, limited studies are available on separation of testa by pre-processing treatments. Therefore, this study aims to analyses the effect of physical nature of the coconut with various temperature and time period.

MATERIAL AND METHODS

All the raw materials (i.e. unmatured coconut and matured coconut) were procured from food processing business incubation center (FPBIC), IIFPT, Thanjavur and local market. The coconut was placed in the appropriate tempered conditions based on their maturity in clean and dry place. The procured raw material was processed with various pre-processing techniques to eliminate testa from its coconut meat. The treatments such as soaking in water, hot water soaking, deep freezing and liquid nitrogen were given at constant temperature (^{0}C) with varied time in minutes (min). The treatment temperature and time were given in the table 1.2

2.1 Physiological properties determination

The physiological properties such as moisture, color, water activity and texture were determined before treating the matured and unmatured coconut. These coconuts were subjected to various temperature and time period for the separation of coconut meat from the brown skin.

2.1.1 Determination of appearance

The physical representation of an act or process through human senses to determine the resemblance or the way of a food product is known as appearance[3]. The appearance of the samples was determined visually.

2.1.2 Determination of moisture

Experimentally, various treated (i.e water, deep freezing, liquid nitrogen) fresh and matured coconut was dried in a batch dryer. In the determination of moisture content, 10 (g) of samples were chopped from randomly selected 5 cups and kept in a convective air dryer, maintained at 105 ± 1^0 C for 5 hrs Y. S., & Ofomaja, A. E.[17].

2.1.3 Determination of color

The color of fresh and matured coconut was analyzed before and after treatment using a hunter color lab. Before keeping the sample, the instrument was done calibration using black and white standardizing templates. The coconut meat was assessed and expressed as L*, a*, b* Chen *et al*.[5].

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

Where,

ΔE= Colour difference between the control and treated sample

ΔL*= L* values difference between control and treated sample

Δa*= a* values difference between control and treated sample

Δb*= b* values difference between control and treated sample

2.1.4 Determination of water activity

The water activity (a_w) was measured using aqua lab water activity meter (Decon devices, Model 4 TE, USA) at 25 ± 0.2 ^{0}C. Water activity of various treated coconut after separation of the brown skin was recorded and tabulated Yong *et al*.[37].

2.1.5 Determination of texture (bio yield: firmness)

In the texture profile analysis, the procedure was described by Thomson *et al*., was followed with minute modifications. Texture profile analysis (TPA) was performed with the view of two varieties under different treatment. Optimum instrumental test conditions were 4 mm (T44), pretest speed 2.00mm/s, test speed of 1.00mm/s and post-test speed of 3.00mm/s. the target parameter was deformation of 75%. The load was 100 g (10N). The TPA test is a 2 cycle test Balasundram *et al*.[2].

2.2 Statistics Analysis:

All the analysis in this was triplicated and reported in mean ± standard deviation. The procured data was analyzed by using IBM SPSS statistical software package with a significance level of 0.05 was taken consideration of paring. For parametric data analysis, one-way ANOVA was done for physicochemical characteristics to determine the significance level during the various treatments.

RESULTS AND DISCUSSION

3.1 Determination of appearance

Figure 1 reports Physical Appearance of untreated and treated samples. The results indicated the effect of different temperature with varying time periods.

Table 3.1 Pictorial representation of matured coconut with various treatments

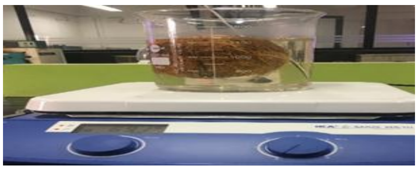
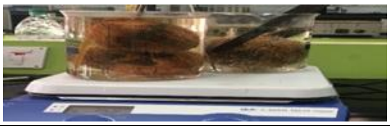
S.no	Treatment	Pictorial representation	
		Before treatment	After treatment
1.	Raw material		
2.	Normal Water		
3.	Hot water		
4.	Deep freezing		
5.	Liquid nitrogen		

Table 3.2 Pictorial representation of fresh coconut with various treatments

S.no	Treatment	Pictorial representation	
		Before treatment	After treatment
1.	Raw material		
2.	Normal Water		
3.	Hot water		
4.	Deep freezing		
5.	Liquid nitrogen		

The unmatured and matured coconut were evaluated visually to check the removal of testa. Table 3.1 & 3.2 shows the appearance of the coconut was before and after treatment. The treatments given were soaking in water, hot water, dep freezing and liquid nitrogen. From the above table 3.1 &3.2, it can be observed, different treatments were subjected to separate the testa from coconut meat. Here in the above picture the appearance of the coconut changes with each treatment[1]. Among the above following treatments, deep freezing had shown transparent separation of the testa and meat from the matured and unmatured coconut.

3.2 Determination of effect of temperature and time on treatments

Table 3.2 Representation of treatments with temperature & time

SN	Treatments		0 hrs	4 hrs	8 hrs	12 hrs	16 hrs	20 hrs	24 hrs	28 hrs	32 hrs	36 hrs
1	Coldwater (27^{0}C -30^{0}C)	f	Testa not removed									
		m	Testa not removed									
2	Hot water (60^{0}C - 70^{0}C)	f	Testa not removed									
		m	Testa not removed									
3	Deep freezing (-18^{0}C to -20^{0}C)	f	testa not removed	slightly testa was separated	40% testa removed	80% removal of testa	physical damage by crystallization					
		m	testa not removed				slight removal of testa	20-30% removal of testa	40-50% removal of testa	50-65% removal of testa	80-95% removal of testa	
4	Liquid nitrogen	F	testa not removed	slightly testa was separated	50% testa removed	80% removal of testa	90% removal of testa	softening of coconut				
		m	testa not removed									

Note: f-fresh coconut; m- matured coconut\

From the above table 3.2, the results show the effect of temperature and time on fresh and matured coconut. Treatments such as soaking, hot water and liquid nitrogen clearly shown that the testa removal was not acceptable compared to deep freezing treatment. This is because the fresh and matured coconut in the deep freezing was affected with conduction and convection process. Therefore, in the process of separating the coconut testa from coconut meat, it was observed that the time period varied because of the variation in the maturity indices. Hence it can be concluded that deep freezing had shown acceptable changes required for the study.

3.3optimization

The optimization of the coconut was done based on the appearance (i.e table 3.1 &3.2) and table 3.3 (representation of treatments with temperature and time period). The above tables represent the separation of the coconut testa and coconut meat from the fresh and matured coconut. The results visualized that the deep freezing have shown the acceptable effect on removal of the testa from both fresh and matured coconut. Therefore, the treatment deep freezing was studied further for physiological changes during various time period.

3.4 Determination of color

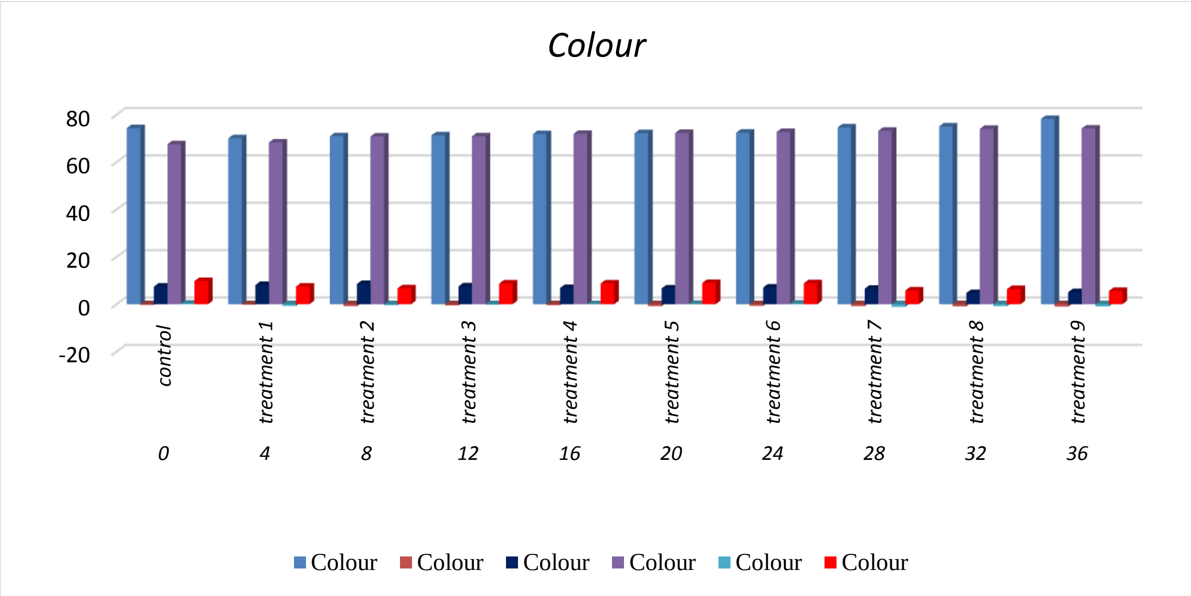


Fig. 3.1 Representation of color change of matured and fresh coconut

The color measurement was an important characteristic shows an infinite variety of appearance characteristics. The color change was measured by hunter colorimeter which was represented in the form of L, a, b, which shows the enzymatic browning changes caused in the coconut during the different treatment as shown in the Fig3.1 above. There was a significant change during the treatment with constant temperature and varying time period. The change in the color was due to the peroxidase and polyphenol oxidase activity. Fig.3.1 indicates noticeable reduction of PPO (polyphenol oxidase) at different treatments for matured and fresh coconut. Nevertheless peroxidase in the samples was slightly active. It was observed that PPO was active for the coconut samples with the treatment of water, hot water compared to deep freezing and liquid nitrogen. The whiteness index of the hot water treatment was decreased compared to other samples because the testa was protecting from the color change McDonald R[26]. Thus as deep freezed samples showed varying color change, it was taken for the further investigation.

3.5 Moisture content

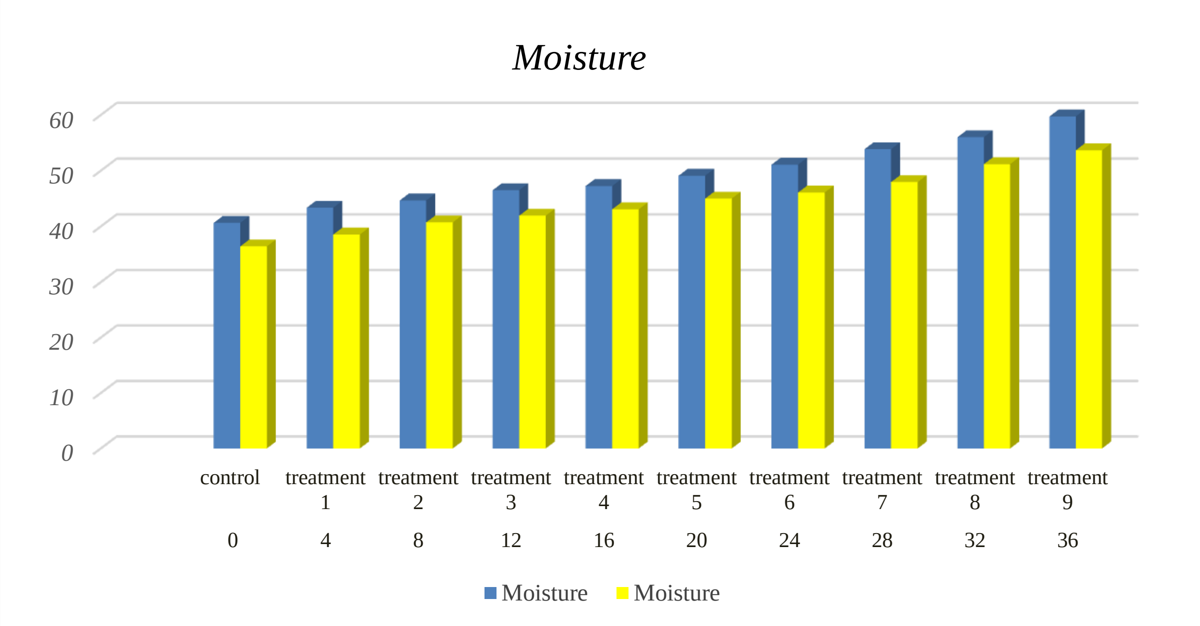


Fig. 3.2 Effect of moisture content of fresh and mature coconut

Moisture content of the coconut is defined as the amount of water present in the coconut. As the coconut contains the moisture in the adsorbed internal surfaces and capillary condensed state, when the treatments such as soaking, freezing and liquid nitrogen were given at constant temperature and varying time, it effects the coconut to swell and loosen the outer layer and coconut meat. From the table 3.1 clearly seen pictorially that deep freezing and liquid nitrogen gases would slowly reduce the temperature and convert the water to crystalline form Johnston, J. C., & Molinero, V.[19]. Therefore, the liquid present in the coconut decreases as the temperature reduces and solidify, thereby it can be confirmed that liquid, thereby chemically hydrogen and oxygen tendenses to form a strong bond between the coconut meat and testa due to intermolecular forces. Hence the treatment affects the density, firmness and color of the coconut. From the above graph it is resulted to give a significant change among the different treatments.

3.6 Determination of water activity

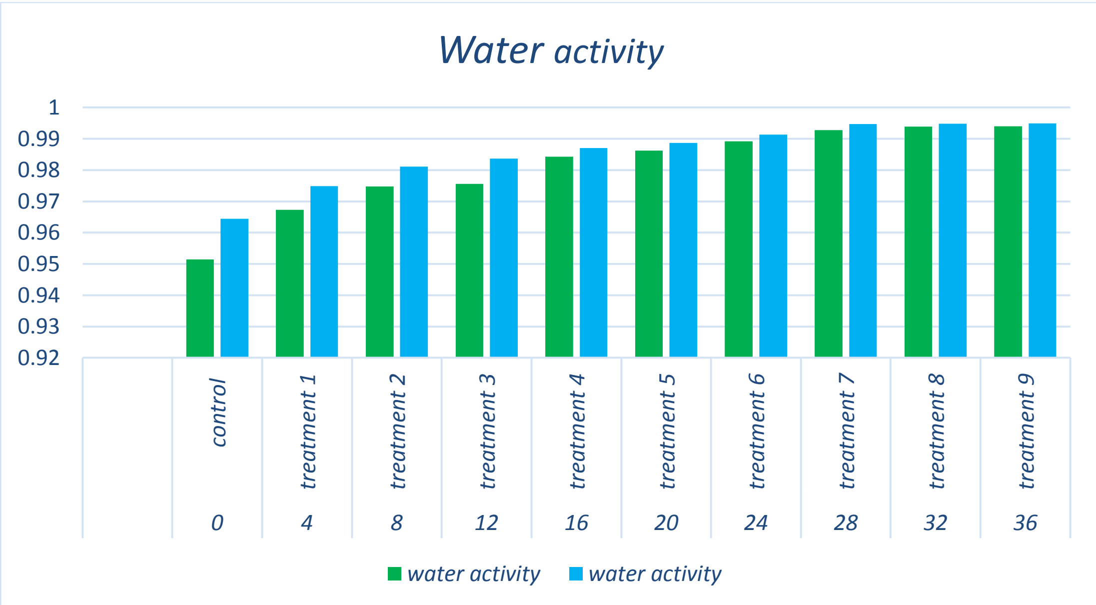


Fig. 3.3 Effect of water activity on fresh and matured coconut

Water activity is defined as measure of durability of the fresh and matured coconut sample with regard to the various spoiling. Water activity indicates the amount of free water in the coconut. The free water presence indicates the micro biotic and enzymatic changes in the process of treatments. In the present study, it provides the information on effect of soaking, hot water, deep freezing and liquid nitrogen with non-chemical bound water in the fresh and matured coconut. The change in form or phase of water is accompanied by an exchange in energy Fletcher, P. D., Howe, A. M., & Robinson, B. H.[14]. Thus, externally produced thermal energy is required to add sufficient heat to change the form from solid to liquid or liquid to vapor. Similarly, as water turns into ice heat energy is released by the food Dincer, I., & MA, T. E. S.[11]. Here in the present study the water activity values of different treatment show with minimum value of 0.95 to 0.98 for fresh and matured coconut samples, which indicates that susceptibility to promote bacterial growth. Fig 3.3 indicates fresh coconut samples shows low water activity than matured coconut. Thus susceptibility of spoilage can be reduced by lowering the water activity of fresh and matured coconut, which in turn influences the product storability.

3.7 Determination of textural analysis

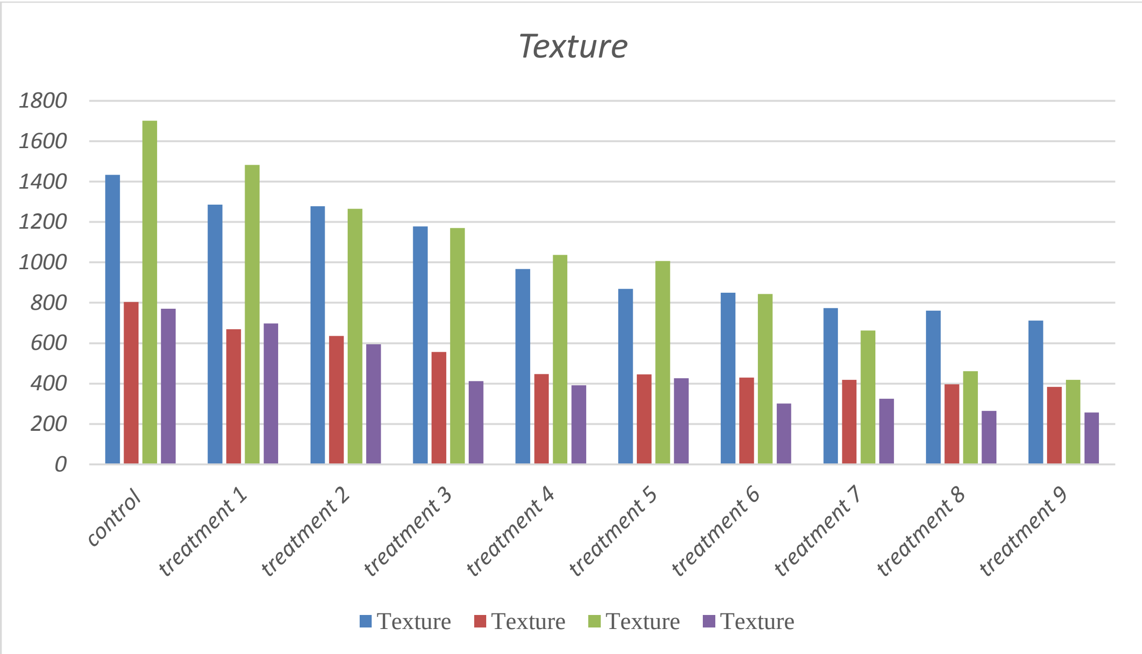


Fig 3.4 effect of texture on fresh and matured coconut

Texture profile refers to visual pattern of repeated elements that had minute amount of changes in the element appearance and relative positions. It infers the product shape orientation and deformation Kallend *et al.*[20]. Hence characterization of the texture was carried out in two main groups, based on sensory and instrumentation analysis Lassoued *et al.*[22]. As sensory analysis was subjected to wide variability, the instrumental analysis was chosen for textural evaluation. Another reason for instrumental analysis may be that often changes in treatments (i.e soaking in water, hot water, deep freezing and liquid nitrogen) levels cause several simultaneous changes in product characteristics. The P/2 probe was used to determine the texture by loading cells. In the present study the textural kinetics in control and different treatment samples, with constant temperature and varying time period. The texture was studied by applying the maximum force (MF) on matured and fresh coconut. The results in the present investigation shown in fig 3.4, shows control sample has the maximum bio yield and firmness compared to other treated samples. This is because (from table 3.1&3.2) of removal of the outer husk of the coconut, thereby it can be concluded that the coconut meat without husk has a poor texture due to oxidation and enzymatic reaction.

4. Interpretation of results

Table 4.1 ANOVA table for fresh or unmatured meat: (significance level 0.05)

ANOVA								
				sum of squres	df	Mean Square	F	Sig.
Moisture	Between Groups	(Combined)		888.972	9	98.775	151.714	0
		Linear Term	Contrast	878.799	1	878.799	1349.8	0
			Deviation	10.173	8	1.272	1.953	0.107
	Within Groups			13.021	20	0.651		
	Total			901.993	29			
Water activity	Between Groups	(Combined)		0.005	9	0.001	6.164	0
		Linear Term	Contrast	0.004	1	0.004	47.425	0
			Deviation	0.001	8	0	1.006	0.462
	Within Groups			0.002	20	0		
	Total			0.007	29			
Bioyield	Between Groups	(Combined)		2953085.898	9	328120.655	77.739	0
		Linear Term	Contrast	2920109.992	1	2920109.992	691.841	0
			Deviation	32975.906	8	4121.988	0.977	0.482
	Within Groups			84415.593	20	4220.78		
	Total			3037501.491	29			
Firmness	Between Groups	(Combined)		686920.928	9	76324.548	33.527	0
		Linear Term	Contrast	639648.139	1	639648.139	280.981	0
			Deviation	47272.789	8	5909.099	2.596	0.04
	Within Groups			45529.657	20	2276.483		
	Total			732450.586	29			
Lightness	Between Groups	(Combined)		251.203	9	27.911	36.09	0
		Linear Term	Contrast	211.448	1	211.448	273.404	0
			Deviation	39.755	8	4.969	6.425	0
	Within Groups			15.468	20	0.773		
	Total			266.671	29			
Greenness	Between Groups	(Combined)		2.318	9	0.258	150.302	0
		Linear Term	Contrast	1.579	1	1.579	921.714	0
			Deviation	0.738	8	0.092	53.875	0
	Within Groups			0.034	20	0.002		
	Total			2.352	29			
Yellowness	Between Groups	(Combined)		43.903	9	4.878	14.02	0
		Linear Term	Contrast	34.852	1	34.852	100.168	0
			Deviation	9.051	8	1.131	3.252	0.015
	Within Groups			6.959	20	0.348		
	Total			50.861	29			

Table 4.2 ANOVA table for copra or matured meat (significance level 0.05)

ANOVA				Sum of Squares	df	Mean Square	F	Sig.
Moisture	Between Groups	(Combined)		802.535	9	89.171	61.207	0
		Linear Term	Contrast	791.941	1	791.941	543.6	0
			Deviation	10.594	8	1.324	0.909	0.529
	Within Groups			29.137	20	1.457		
	Total			831.672	29			
Water activity	Between Groups	(Combined)		0.003	9	0	2.655	0.033
		Linear Term	Contrast	0.002	1	0.002	19.738	0
			Deviation	0.001	8	0	0.519	0.828
	Within Groups			0.002	20	0		
	Total			0.005	29			
Bioyield	Between Groups	(Combined)		4195072.628	9	466119.181	13.682	0
		Linear Term	Contrast	4161741.017	1	4161741.017	122.16	0
			Deviation	33331.611	8	4166.451	0.122	0.998
	Within Groups			681353.493	20	34067.675		
	Total			4876426.121	29			
Firmness	Between Groups	(Combined)		885582.273	9	98398.03	9.564	0
		Linear Term	Contrast	768056.335	1	768056.335	74.655	0
			Deviation	117525.937	8	14690.742	1.428	0.245
	Within Groups			205762.448	20	10288.122		
	Total			1091344.72	29			
Lightness	Between Groups	(Combined)		996.332	9	110.704	18.061	0
		Linear Term	Contrast	940.261	1	940.261	153.4	0
			Deviation	56.071	8	7.009	1.144	0.378
	Within Groups			122.586	20	6.129		
	Total			1118.918	29			
Greenness	Between Groups	(Combined)		7.088	9	0.788	7.889	0
		Linear Term	Contrast	1.592	1	1.592	15.946	0.001
			Deviation	5.496	8	0.687	6.881	0
	Within Groups			1.997	20	0.1		
	Total			9.085	29			
Yellowness	Between Groups	(Combined)		23.779	9	2.642	2.771	0.028
		Linear Term	Contrast	3.562	1	3.562	3.736	0.068
			Deviation	20.218	8	2.527	2.651	0.037
	Within Groups			19.067	20	0.953		
	Total			42.847	29			

One-way ANOVA was conducted to evaluate the relationship between the coconut meat and testa removal using the different treatments (i.e soaking in water, hot water, deep freezing and liquid nitrogen. The independent variables, fresh and matured coconut indexed included two levels: low SS and high SS. The dependent variables temperature and time period. The ANOVA was significant for the both fresh and matured coconut samples as shown in the table 4.2 and 4.3. The results of the ANOVA allowed to rejecting the null hypothesis H_0 and supporting the conclusion that there is a statistically significant and strong effect of treatment and time in separation of coconut testa and coconut meat.

CONCLUSION

The pre-processing techniques such as soaking in water, hot water soaking deep freezing and liquid nitrogen treatments were subjected to isolate coconut meat and testa from fresh and matured coconut. The optimization was done on the basis of pictorial representation (i.e appearance) and temperature with varying time period. The deep freezing has shown an acceptable result towards separation process in fresh and matured coconut. Among the optimized sample in deep freezing, the fresh and matured coconut have favorable separation of coconut meat and testa when temperature/hour is at (-18^{0}C/12hrs) and (-18^{0}C/36 hrs). The physiological study such as moisture content (%), water activity, color and texture have shown a significant changes in ANOVA table. Hence it can be concluded that, deep freezing shows considerable changes in separation of coconut testa and coconut meat in fresh and matured coconut.

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