ПОЉОПРИВРЕДНА ТЕХНИКА

AGRICULTURAL ENGINEERING

НАУЧНИ ЧАСОПИС
SCIENTIFIC JOURNAL
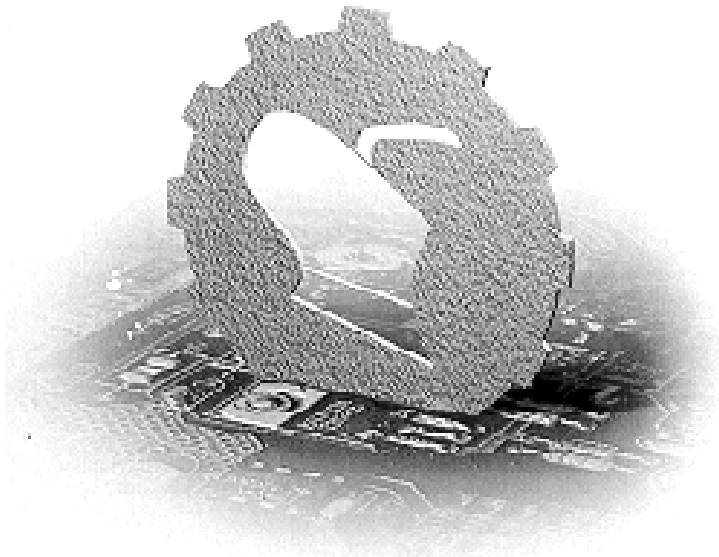
УНИВЕРЗИТЕТ У БЕОГРАДУ, ПОЉОПРИВРЕДНИ ФАКУЛТЕТ,
ИНСТИТУТ ЗА ПОЉОПРИВРЕДНУ ТЕХНИКУ
UNIVERSITY OF BELGRADE, FACULTY OF AGRICULTURE,
INSTITUTE OF AGRICULTURAL ENGINEERING

Година XLVIII, Број 3., 2023.
Year XLVIII, No.3., 2023.

ПОЉОПРИВРЕДНА ТЕХНИКА

AGRICULTURAL ENGINEERING

S A D R Ž A J

C O N T E N T S

THE IMPORTANCE OF THE APPLICATION OF INTERNAL CONTROL IN THE PROCESSES OF SECURE FINANCIAL AND GENERAL MANAGEMENT IN AGRICULTURAL ENTERPRISES IN REPUBLIC OF SERBIA

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Summary: A country in transition, like the Republic of Serbia, needs to create conditions in which it will be possible to structurally improve the management process in a large number of heterogeneous companies. In this study, the authors emphasized the importance of encouraging the improvement of management through the practical application of internal control in agricultural enterprises. Comparative comparisons were made between two forms of established internal control in agricultural enterprises with the aim of discovering differences on that basis. Then they performed an additional analysis of the form of internal control in relation to the three levels of introduced internal control based on the intensity of introduced internal control in the regular business processes of the mentioned companies.

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The third and largest contribution of the author in the study stems from the observation of the mentioned introduced internal control and the achieved business results in the form of realized income at the end of the business year.

The results obtained by the authors of the study are such that the obtained value of the Chi-square test is 6.281, i.e. $p<.05$, which proved that the use of the form of internal control by intensity affects the amount of income achieved in agricultural enterprises, i.e. the establishment of internal control is important for making valid management decisions by top management.

Keywords: internal control, management, income generation.

INTRODUCTION

Internal control in the organization of agricultural production has a role that increasingly takes the place of an assistant in terms of strengthening the decisions made by the top management of the company.

This type of organization in companies includes the complete business where the internal control function is apart from the management function and with elements of advisory activity, primarily top management, but also other management structures in the company [1-5].

Internal control includes the control of all parts of the company, it is essentially determined to create and contribute to raising liquidity, business efficiency, raising the success of factors such as productivity, efficiency and effectiveness as well as maximizing business efficiency [6-8].

Internal control can contribute to increasing work safety for small and growing businesses, but what is even more important for the work and business of agricultural enterprises [9-10].

Through the work of internal control, there is a significant increase in security in business and the establishment of controls and monitoring of the results of business activities. In this way, the overall security of the operations of the mentioned companies is achieved, which is the key to successful operations [11-13].

In addition, the reporting that management receives on a daily, weekly or monthly basis contributes to making better business decisions, and it is fundamentally based on valid business documentation [14-15].

APPLICATIONS OF INTERNAL CONTROL MECHANISMS IN AGRICULTURAL ENTERPRISES IN THE REPUBLIC OF SERBIA

After the decision of the top management to introduce an internal control mechanism into the regular operations of the company, it is possible to analyze the application of internal control mechanisms in agricultural companies in the Republic of Serbia,
with the aim of strengthening the views of the validity of introducing it into the regular operations of the company.

APPLICATION OF LARGE AND SMALL INTERNAL CONTROLS IN AGRICULTURAL ENTERPRISES

The research was conducted in 278 surveyed internal controls, namely: 54 large internal controls in companies that are primarily engaged in agricultural production and 224 medium internal controls. Large internal controls included 4 controls during 2022, while medium internal controls included 2 controls during one calendar year. The form of internal control included three levels: low, medium and high level of internal control in companies.

The authors provided an overview of performed and unperformed large and medium internal controls in agricultural enterprises in Table 1 and Table 2.

Table 1. Overview of completed and uncompleted long internal controls in agricultural enterprises

A form of internal control by intensity	Apply internal control mechanisms		Failure of internal control mechanisms		Total	
	No.	%	No.	%	No.	%
Low level of performed internal control	4	25	12	75	16	100
Medium level of performed internal control	10	76,92	3	23,08	13	100
High level of performed internal control	20	80	5	20	25	100
Total	34	62,96	20	37,04	54	100

Source: Authors' calculations

Table 2. Overview of performed and not performed Intermediate internal controls in agricultural enterprises

A form of internal control by intensity	Apply internal control mechanisms		Failure of internal control mechanisms		Total	
	No.	%	No.	%	No.	%
Low level of performed internal control	12	13,65	76	86,35	88	100
Medium level of performed internal control	68	80,95	16	19,05	84	100
High level of performed internal control	16	30,77	36	69,23	52	100
Total	96	42,86	128	57,14	224	100

Source: Authors' calculations

**TESTING THE RELATIONSHIP OF THE FORMS OF INTERNAL CONTROL
ACCORDING TO THE INTENSITY OF THE ESTABLISHED INTERNAL
CONTROL MECHANISMS IN AGRICULTURAL ENTERPRISES
AND THE AMOUNT OF INCOME ACHIEVED**

The relationship between the form of internal control and the intensity of established internal control mechanisms in agricultural enterprises and the amount of income achieved can be determined based on the testing done by the authors using the Chi-square test.

After the test, the authors presented the test results in Table 3. The results were presented in order to determine the relationship between the form of internal control by the intensity of the established internal control mechanisms in agricultural enterprises and the different amounts of income they achieve.

Table 3. Results of the Chi-square test, the realization of the use of forms of internal control according to the intensity of established internal control mechanisms in agricultural enterprises and the amount of income

Obtained results	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.065[a]	1	.008		
Continuity Correction[b]	6.281	1	.012		
Likelihood Ratio	7.092	1	.008		
Fisher's Exact Test				.010	.006
Linear-by-Linear Association	7.040	1	.008		
N of Valid Cases	278				

Source: Authors' calculations

DISCUSSION

The results obtained are such that one can see the existence of a clear difference in the number of implemented large internal controls in agricultural enterprises. Namely, 34 internal controls were implemented, which is about 63% compared to 20 that were not implemented, or about 37%.

There are also differences in medium internal controls in agricultural enterprises, which can be seen from the existence of a clear difference in the number of implemented large internal controls in agricultural enterprises. Namely, 96 internal controls were implemented, which is about 43% compared to 128 that were not implemented, or about 57%.

Based on the values in the Chi-square tests, the obtained value is 6.281, essentially p<.05. In other words, the realization of the use of forms of internal control by the intensity of established internal control mechanisms in agricultural enterprises and the amount of income is considerable.

The results show that there is a great dependence between the relationship between the established form of the degree of internal control and the realization of the income realized in the agricultural enterprise.

CONCLUSION

The research done by the authors of the study indicates that there are three important conclusions. The first is that there are significant differences in the number of implemented internal controls in agricultural enterprises. Pronounced deviations in the number of performed internal controls are visible both in large and medium-sized internal controls that are carried out in the operations of agricultural enterprises. Large internal controls are essentially small 4 regular process controls in contrast to medium ones which are small 2 controls during one calendar year. The second conclusion is that there are three forms of application of internal control that included three levels of control, namely: low, medium and high level of implementation of internal control in agricultural enterprises. The third conclusion would be that the authors discovered that there is a connection between the form of the established form of the level of internal control and the income generated by agricultural enterprises. Based on the obtained values of the Chi-square test, where the obtained value was 6.281, p<.05, it was confirmed that the use of forms of internal control according to the intensity of established internal control mechanisms in agricultural enterprises and the amount of income is significant, that is, it is important for making valid management decisions top management.

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ZNAČAJ PRIMENE INTERNE KONTROLE U PROCESIMA SIGURNOG FINANSIJSKOG I OPŠTEG UPRAVLJANJA U POLJOPRIVREDNIM PREDUZEĆIMA U REPUBLICI SRBIJI

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Sažetak: Zemlja u tranziciji, poput Republike Srbije, treba da stvori uslove u kojima će moći izvršiti strukturalno unapređenje procesa upravljanja u velikom broju heterogenih preduzeća. U ovoj studiji autori su istakli značaj podsticanja unapređenja upravljanja putem praktične primene interne kontrole u poljoprivrednim preduzećima.

Urađena su komparativna poređenja između dva oblika uspostavljene interne kontrole u poljoprivrednim preduzećima sa ciljem otkrivanja razlika po tom osnovu. Potom su autori uradili dodatno analiziranje oblika interne kontrole u odnosu na tri nivoa uvedene interne kontrole po osnovu intenziteta uvedene interne kontrole u procese redovnog poslovanja pomenutih preduzeća.

Najveći doprinos Autora u ovoj studiji proizilazi iz posmatranja pomenute uvedene interne kontrole i ostvarenih rezultata poslovanja u vidu ostvarenog dohotka na kraju poslovne godine.

Rezultati do kojih su došli autori studije su takvi da dobijena vrednost Hi-kvadrat testa iznosi 6,281, odnosno $p<.05.$, čime su dokazali da upotreba oblika interne kontrole po intenzitetu utiče na visinu ostvarenog dohotka u poljoprivrednim preduzećima, odnosno uspostavljanje interne kontrole je bitno za donošenje validnih upravljačkih odluka od strane top menadžmenta.

Ključne reči: interna kontrola, upravljanje, ostvarenje dohotka.
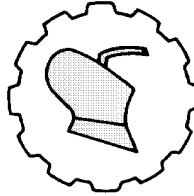
MINIMALLY PROCESSED TOMATO USING A SIMPLE DEVELOPED FILTRATION DEVICE, COMMON SALT AND VEGETABLE OIL CAN PRESERVE TOMATO CONCENTRATE

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Abstract: In attempt to produce and preserve tomato concentrate, without destroying some useful nutrients, in a rural area where there is no electricity, a minimal processing method is necessary. In this study, a simple filtration unit was developed. Fresh tomatoes (*Solanum lycopersicum*) (3.50 kg) were bought, cleaned and blended. Initial moisture content (MC) of the slurry (3.0 g) was determined and 3.0 kg slurry filtered. The amounts of concentrate, filtrate and filtration period were noted. Initial MC of the concentrate was also found. A mixture of concentrate (200 g), vegetable oil (30 ml) and salt (12.0 g) was prepared for preservation as sample A. This was re-prepared but with 10.0 and 8.0 g of salt as samples B and C. pH, colour and lycopene content of the test samples were found before and during preservation at a week-interval for 2 months in duplicates. The results showed that the initial MC of the fresh tomato / slurry and concentrate were 93.5 and 73.3%, respectively. Test sample pH before preservation was 4.22. Sample A recorded 18.79% decrease in pH while B and C had 9.2% and 54% increase in pH, respectively.

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Visual observation after 8ᵗʰ week of preservation showed that the tomato concentrate was still reddish but colour change (ΔE) from the colorimeter revealed that sample

A had the least value of 6.09 while B and C were 7.31 and 8.53, respectively. Initial lycopene concentration was 14.11 mg /100 g product.
After preservation, Sample A had the least decrease (19.63%) compared to sample B (29.91% decrease) and sample C (33.3% decrease). Hence, common salt (12.0 g) and vegetable oil (30 ml) were able to maintain the acid content and minimize the reduction in lycopene content in the tomato concentrate.

INTRODUCTION

Tomato (*Solanum lycopersicum*) is a common fruit consumed in many parts of the world. Its origin is traced from South America. The tomato fruit can be consumed as fresh product or processed product such as tomato juice, sun-dried tomato, tomato jam and pulp, canned whole tomato, ketchup (sauce), tomato paste, tomato leathers, tomato chutney and chill sauce [1]. The tomato fruit is like berry. It is red or yellow in colour, and between 15 – 75 mm in diameter. It varies in shape from oval, elongate to pear shape (Fig.1).

Fig.1. Fresh tomato (*Solanum lycopersicum*)

Whole tomato has some valuable nutrients such as vitamin C, lot of minerals and sugars [2]. The fruit has lycopene which is so beneficial to human health [3]. Proximate analysis of the ripe tomato fruit showed the presence of water (93.80%), carbohydrate (2.52%), protein (1.0%), ash (0.85%), crude fibre (1.21%) and crude fat (0.62%) [4]. Many tomato cultivars have between 4.5 to 7.8% soluble solids. The pH of fresh tomatoes is within 4.3 to 4.9. However, for the purpose of processing and preservation to avoid microbial spoilage, its pH should be 4.6 [5, 6]. The major organic acid present in tomato juice is the citric acid and malic acid among others. These acids play important roles in the manufacture and release of energy; while some major amino acids found are the glutei acid, methionine and 5 methyl methionine, etc. Fruits and vegetables have important daily dietary functions in terms of promoting good health based on their composition: vitamins, antioxidants, microelements, etc. However, consumers give more preference to less processed, more convenient and safer foods.

This has led to the formulation of minimally processed foods [7]. Parameters such as pH, temperature, water activity, etc., could play very vital role in the preservation of processed food [8, 9, 10].

Furthermore, immediately after crop harvesting, deterioration process sets in, much rapid, especially in fruits and vegetables within few days. This is more predominant in rural areas where there are no adequate technologies to minimize the effects (spoilage and wastage). Typically, as soon as tomato fruits are harvested, deterioration begins. Heat application, during processing to preserve them, destroys some valuable natural ingredients and even eludes their freshness [11]. Common salt has an important role in reducing pathogens and organisms' growth that spoil food products. Vegetable oil in contact with fresh food material in a sealed container would inhibit further deterioration [12]. Therefore, the main objective of this study was to employ minimal processing methods in preserving tomato concentrate using a simple fabricated filtration device, common salt and vegetable oil.

MATERIALS AND METHODS

DESIGN OF SIMPLE FILTRATION DEVICE

Design Concept and Consideration

The design perception behinds the device is that the slurry is filtered under the influence of gravity and atmospheric pressure. The materials used for construction do not contaminate the products.

Design Calculations and Analysis of Some Major Parts of Simple Filtration Device

(I) Hopper

This is a cylindrical vessel with a lid and handle. It is made from stainless steel plates. The lid is perforated with 6 holes (10 mm in diameter) which allow the filtration process under the influence of gravity and atmospheric pressure. Under the lid is impregnated with a clean white cloth to shield the system from extraneous materials. The surface area of the lid (S_l), curve surface area (S_C) and volume of the cylindrical vessel (V_C) are given in Equations 1, 2 and 3.

$$S_l = \frac{\pi}{2} d_l^2 \qquad \qquad \text{...........(1)}$$
$$S_C = \pi . d_C \, h \qquad \qquad \text{..........(2)}$$
$$V_C = \frac{\pi}{4} d_i^2 \, h \qquad \qquad \text{..........(3)}$$

Where,

d_l = external diameter of the lid (cover) (mm),

d_C = external diameter of the cylindrical vessel (mm),

h = height of the cylindrical vessel (mm),

d_i = internal diameter of the cylindrical vessel (mm).

(II) Filter Material

Muslin cloth is used as filter material. It is cut in the form of a circular surface with allowance to cover the rim of the funnel. Its surface area (S_{MC}) was calculated using Equation 1. However, its diameter is greater than d_l by 10 mm.

(III) Funnel

This is a conical segment of the filter with a short cylindrical tube that allows the dripping of the filtrate. It is made from stainless steel plate. The total surface area ($f_{t.s}$) and volume of the funnel (f_v) were calculated using Equation 4 to 8 as:

$$\text{Area of the curved surface of funnel} = \frac{\pi \cdot d_{ef} \cdot l_f}{2} \qquad \ldots\ldots\ldots\ldots\ldots \text{(4)}$$

$$\text{Slant height of the conical segment, } l_f = \frac{d_{ef}}{2\cos\theta} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

Area of the curved surface of short cylindrical tube
$$= \pi \cdot d_{short\ cyl.} \cdot h_{short\ cyl.} \qquad \ldots\ldots\ldots\ldots\ldots..\ldots \text{(6)}$$

$$f_{t.s} = \left(\frac{\pi \cdot d_{ef} \cdot l_f}{2}\right) + \left(\pi \cdot d_{short\ cyl.} \cdot h_{short\ cyl.}\right) \qquad \ldots\ldots\ldots\ldots\ldots \text{(7)}$$

$$f_{vol.} = \frac{\pi \cdot d_{if}^2 \cdot h_f}{3 \times 4} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(8)}$$

Where

d_{ef} = eternal diameter of the funnel (mm),

θ = angle depression of the conical segment (^{0}),

$d_{short\ cyl.}$ = diameter of the short cylindrical tube (mm),

$H_{short\ cyl.}$ = height of a short cylindrical tube (mm),

d_{if} = internal diameter of the funnel (mm),

h_f = height of the funnel (30 mm).

(IV) Filtrate Collector

This is a transparent container that receives the filtrate during filtration. It is used to monitor the rate of flow. It has a lid with 6 perforated holes for the release of internal pressure. Under the lid too, is impregnated with a clean white cloth to prevent extraneous materials. Its volume was estimated using Equation 3 and based on expected volume of the filtrate per experimental run.

(V) Frame

This is a stand with 4 supports that is made from 10 mm thickness iron rod. The length of the rod that forms the stand was calculated thus:

$$L_{t.rod} = L_{c.rod} + (4L_{l-shaped\ rod}) \qquad \ldots\ldots\ldots\ldots. \text{(9)}$$
$$L_{c.rod} = \pi \cdot d_{c.rod} \qquad \ldots\ldots\ldots\ldots\ldots \text{(10)}$$
$$L_{l-shaped\ rod} = \text{rod height + rod base} \qquad \ldots\ldots\ldots\ldots\ldots \text{(11)}$$

Where,

$L_{t.rod}$ = total length of the rod (mm),

$L_{c.\ rod}$ = circumference of the circular rod (mm),

$L_{l-shaped\ rod}$ = length of the *l*-shaped rods (mm) and
$d_{c.rod}$ = diameter of circular rod (mm).

PROCEDURE

Tomatoes (*Solanum lycopersicum*) (3.50 kg) were bought from Akpan Andem Market, Uyo, Akwa Ibom State. They were selected at random, washed in distilled water to eliminate extraneous materials, and mopped with clean cloth to remove the surface moisture. The wounded or perishable samples were removed and the good ones stored in clean containers. The samples were weighed using digital weighing balance. The bulk sample (3.05 kg) was blended using an electric blender. The slurry (30.0 g) was used in determining initial moisture content of the bulk samples by oven dry method as described by ASABE [13], Assian and Alonge [14], Antia *et al.* [15] using Equation 12. Exactly 3.0 kg of the slurry was taken out for filtration using simple fabricated filtration device (Fig. 2). Mass of tomato concentrate obtained was measured and its moisture content found. Approximately 200 g of the concentrate was measured into a transparent container. Then, 12.0 g of common salt (NaCl) and 30 ml of vegetable oil were added and mixed properly. The pH, colour and lycopene content of the test samples were determined before preservation, and then the transparent container was covered. These readings were taken at a week-interval for 2 months. The experiment was repeated with the same amount of tomato concentrate and vegetable oil but with 10.0 and 8.0 g of common salt as samples B and C. The experiment was conducted in duplicates. The plots of pH, colour and lycopene content against period of preservation were made.

Moisture Content Determination

The sample moisture content percent wet basis ($\% M_{wb}$) was determined using Equation 12.

$$\% MC_{wb} = \frac{M_i - M_{bd}}{M_i} \times 100\% \qquad\qquad\qquad ....(12)$$

Where,
M_i = initial mass of the sample (g),
M_{bd} = sample mass at bone dry condition (g).

Determination of pH
The test sample pH was found using Jenway pH meter as described by HACH, [16].

Determination of Colour Using Colorimeter
The colours of the control and preserved samples were examined using colorimeter (CA 10). The corresponding values of "*L*", "*a*" and "*b*" which indicate lightness, redness and yellowness degree, respectively, were read and noted for the control and preserved samples. Then, colour difference (ΔE) was computed thus [17, 18]:

$$\Delta E = \sqrt{(L_o - L)^2 + (a_o - a)^2 + (b_o - b)^2} \qquad\qquad ....(13)$$

Where,

L_o, a_o and b_o represent the colour parameters for the control samples (i.e., samples at zero minutes of preservation) while
L, a and *b* represent that of the preserved samples after several days.

Extraction and Determination of Lycopene Concentration Using Spectrophotometer SSI UV 2101

Lycopene content was extracted from the concentrate and the preserved samples with the mixture of hexane: ethanol: acetone in the ratio 2:1:1 (v/v). The mixture (25 ml) and test sample (1.0 g) were homogenized for 30 mins in a test tube using rotary mixer for 30 min. Distilled water (10 ml) was added and mixing continued for extra 3 min. The solution was kept to separate into polar and non-polar layers. Then, the absorbance was read at 502 nm, using hexane as a blank. The concentration of lycopene was computed using its specific extinction coefficient (E 1%, 1 cm) of 3150 in hexane at 502 nm, [19].

$$\text{Lycopene content (mg / 100 g)} = \frac{E \times 20}{3.15 \times M} \qquad \text{.................. (14)}$$

Where, E= extinction coefficient, M = mass of the test sample (g)

RESULTS AND DISCUSSIONS

Simple Filtration Device
Based on the designed formulas in Materials and Methods, the following were obtained:
 (i) **Hopper**

d_l = 160 mm, d_C = 150 mm), h = (50 mm), d_i = 140 mm, S_l = 40217.6 mm^2,
S_C = 23565 mm^2 and $V_C = 769790$ mm^3 ($\approx$ 0.77 litres).

(ii)   **Filter Material**
S_{MC} = 45401.9 mm^2

(iii)   **Funnel**
 d_{ef} = 160 mm, $\Theta = 20^0$, $d_{short\ cyl.}$ = 20 mm, $h_{short\ cyl.}$ = 15 mm,
 d_{if} = 154 mm, h_f = 30 mm,
Area of the curved surface of funnel = 21399.69 mm^2,
 $l_f = 85.13$ mm, area of the curved surface of short cylindrical tube = 942.6 mm^2,
$f_{t.s}$ = 22342.2905 mm^2 and $f_{vol.} = 186289.18$ mm3 ($\approx$ 0.19 *l*).

(iv) Filtrate Collector

d_{fC} = filtrate collector diameter (100 mm), h_{fC} = filtrate collector height (120 mm) and V_{fC} = filtrate collector capacity (942600 mm^3 or 0.943 litres); hence, one litre container was purchased.

(v)   Frame

$d_{c.rod}$ = 180 mm, rod height = 178 mm, rod base = 30 mm and $L_{t.rod}$ = 1397.56 mm.

However, the 3-D model of simple filtration device is presented in Fig 2.
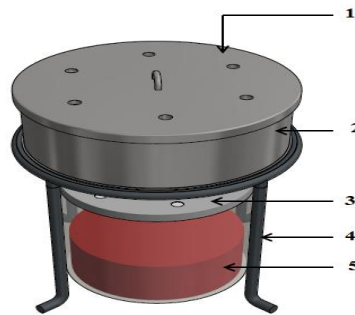
1- Cover; 2-Hopper; 3- Filtrate lid; 4- Frame; 5-Transparent container

Fig. 2. Simple filtration device

Average Moisture Contents of the Fresh Tomato Slurry and Concentrate

The average moisture contents of the fresh tomato slurry and concentrate were 93.5 $\pm$ 2.5% and 73.3 $\pm$ 2.9%, respectively. The observed MC of tomato concentrate was lower than that of the slurry due to the fact that part of it had filtered away. Approximately 1.2 kg of the concentrate and 1.74 liters ($\approx$ 1.74 kg) of filtrate were got from 3.0 kg of tomato slurry after about 66 minutes of filtration (Fig. 3).

Fig. 3. Tomato slurry, filtrate and concentrate

Test Samples pH before and during Preservation

The plots of test samples pH before and during preservation are presented in Fig. 4.
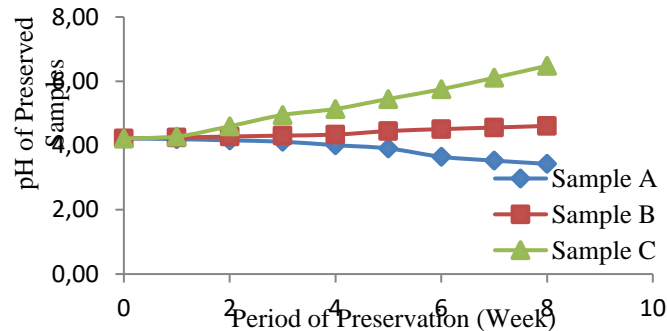
Fig. 4. Plots of pH test samples pH before and during preservation

As seen in Fig. 4, the initial pH of the test samples before preservation was 4.22. Sample A (12.0 g of salt) recorded 18.79% decrease in pH value during the period of preservation whereas samples B (10.0 g of salt) and C (8.0 g of salt) had 9.2% and 54% increase in pH values, respectively. This implies that the more the amount of salt in the tomato concentrate the more acidic it becomes. Hence, it is difficult for microbial attack on sample A with the pH of 3.43 at the 8th weeks of preservation, and so, there was no spoilage. Sample B recorded a very slow deterioration rate. Sample C was closed to neutrality; hence, the tomato concentrate may no longer safe for consumption according to CODEX Alimentarius [20] standard for processed tomato concentrate with acceptable pH value of 4.6.

Colour of the Test Samples before and during Preservation

The colour and plots of colour change in the test samples (ΔE) before and during preservation are presented in Fig. 5 and 6.

Fig. 5. Colour of the test samples before and during preservation
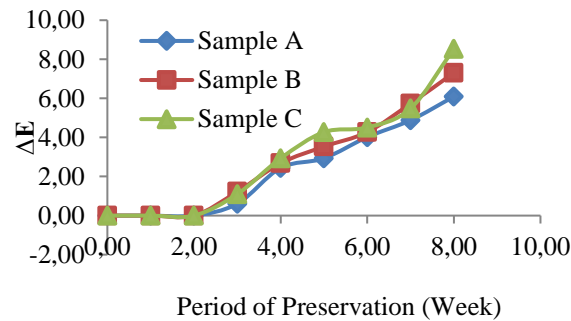
Fig. 6. Plots of ΔE in the test samples against period of preservation

From Fig. 5, visual observation after 8th week of preservation revealed that the colour of the tomato concentrate was still reddish. However, based on instrumentation, there was no ΔE at the end of the 2nd week of preservation, and after this period, a steady increase in ΔE was noted till the 8th week in all the test samples as seen in Fig 6. Besides, sample C recorded the highest ΔE (8.53); followed by sample B (7.31) and Sample A (6.09) being the least. The least ΔE in sample A might have been due to the ability of the mixture of the vegetable oil and such amount of salt to keep the lycopene in the tomato concentrate intact.

Lycopene Content of the Test Samples before and during Preservation
The plots of lycopene concentration versus period of preservation are shown in Fig.7.
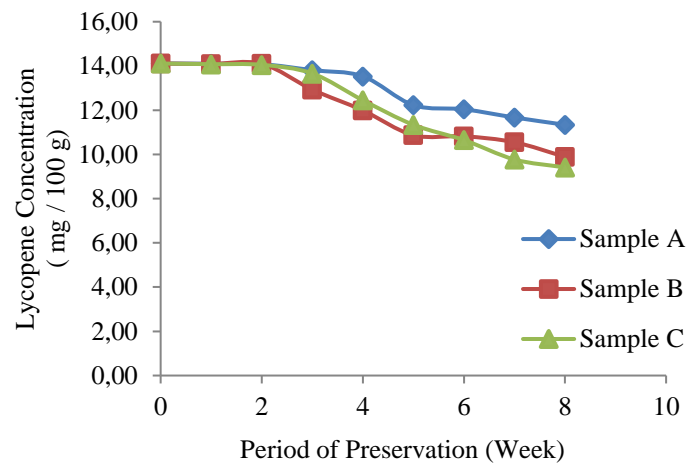
Fig. 7. Plots of lycopene concentration versus period of preservation

From Fig.7, the initial lycopene concentration found for test sample before preservation was 14.11 mg /100 g product. There was no significant variation in lycopene concentration in the test samples at the end of 2nd week of preservation as 14.08, 14.10 and 14.05 mg / 100 g of samples A, B and C, respectively.

Beyond this period, the concentration decreased till the 8th week as 11.34, 9.89 and 9.41 mg / 100 g of samples A, B and C, respectively. However, sample C recorded the highest % decrease (33.30%), followed by sample B (29.91%) and lastly sample A (19.63%). Sample A with the least decrease might have been due to more acidic content of the concentrate.

CONCLUSION

In this study, fresh tomato samples minimally processed into concentrate using simple fabricated filtration unit, 12.0 g common salt and 30 ml vegetable oil were able to maintain the acid medium and minimize the decrease in lycopene content.

In rural areas where there is no electricity, this method could be used in making and preserving healthy and safe tomato concentrate without application of heat or the use of refrigeration.

CONFLICT OF INTEREST

None is declared.

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MINIMALNO PRERAĐEN PARADAJZ POMOĆU JEDNOSTAVNO RAZVIJENOG UREĐAJA ZA FILTRACIJU, -OBIČNA SO I BILJNO ULJE MOGU OČUVATI KONCENTRAT PARADAJZA

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Abstrakt: U pokušaju da se proizvede i sačuva koncentrat paradajza, a da se pritom ne unište neke korisne hranljive materije, u ruralnom području Nigerije, gde nema struje, neophodna je minimalna metoda prerade. U ovoj studiji razvijena je jednostavna jedinica za filtriranje. Sveži paradajz (*Solanum licopersicum*) (3,50 kg) je otkupljen, očišćen i izmešan. Određen je početni sadržaj vlage (MC) suspenzije (3,0 g) i filtrirano 3,0 kg kaše. Ustanovljene su količine koncentrata, filtrata i perioda filtracije. Nađena je i MC koncentrata.

Mešavina koncentrata (200 g), biljnog ulja (30 ml) i soli (12,0 g) pripremljena je za konzervaciju kao uzorak A. Ovo je ponovo pripremljeno ali sa 10,0 i 8,0 g soli kao uzorci B i C.

Vrednost pH, boja i sadržaj likopena testiranih uzoraka su pronađeni pre i tokom čuvanja u nedeljnom intervalu tokom 2 meseca.

Rezultati su pokazali da je početni MC svežeg paradajza/kaše i koncentrata bio 93,5 73,3%. Vrednost pH uzorka testa pre konzervisanja bio je 4,22.

Uzorak A je imao smanjenje pH od 18,79%, dok su B i C imali povećanje vrednosti pH od 9,2% i 54%, respektivno.

Vizuelno posmatranje posle osme nedelje čuvanja pokazalo je da je koncentrat paradajza i dalje bio crvenkast, ali je promena boje (ΔE) na kolorimetru pokazala da uzorak A ima najmanju vrednost od 6,09 dok su B i C 7,31 i 8,53, respektivno.

Početna koncentracija likopena bila je 14,11mg/100g proizvoda. Nakon konzervacije, uzorak A je imao najmanje smanjenje (19,63%) u poređenju sa uzorkom B (smanjenje od 29,91%) i uzorkom C (smanjenje od 33,3%).

Dakle, obična so (količina 12,0 g) i biljno ulje (30 ml) su bili u stanju da održe sadržaj kiseline i minimiziraju smanjenje sadržaja likopena u koncentratu paradajza.

Ključne reči: *Jednostavna jedinica za filtriranje, metoda prerade, koncentrat paradajza, čuvanje.*
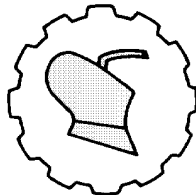
FACTORS INFLUENCING WOMEN'S INVOLVEMENT IN PALM OIL PROCESSING IN IFE NORTH LOCAL GOVERNMENT AREA OF OSUN STATE NIGERIA

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Abstract: The study assessed women's involvement in palm oil processing in Ife North Local Government Area, Osun State, Nigeria. A multistage sampling procedure was used to select 120 women palm oil processors. Primary data collected with the aid of well-structured interview schedule were subjected to frequency counts, percentage, mean, standard deviation and Chi-square analysis. The results reveal that majority (73.3%) of the palm oil processors were married, with the mean age of 50.2 ± 15.173 years and years of palm oil processing experience averaged $24.713 + 13.670$. Oil drying, $\bar{x}=3.87$, ranked 1st of all the processing activities the respondents were involved in. Close to half (47.5%) of the women palm oil processors were at a medium level of involvement. High cost of labour and transportation ranked 1st with a weighted mean score of $\bar{x} = 3.04$ of all the constraints. There was significant association between age ($\chi 2=18.730$, p=0.001), marital status ($\chi 2=15.663$, p=0.047), primary occupation ($\chi 2=20.207$, p=0.003), level of education ($\chi 2=15.821$, p=0.045), experience ($\chi 2=16.607$, p=0.034) and involvement in palm oil processing. The study concluded that there was medium level of involvement in palm oil processing among the women.

It was recommended that governmental and non-governmental agricultural agencies should introduce modern method of palm oil processing to the women palm oil processors in the study area.

Key words: Palm oil, processing, women, socio-economic, constraints.

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INTRODUCTION

In Nigeria, women make a large proportion of the agricultural labor force [1]. [2] argued that women account for 70 – 80% of household food production in Sub-Sahara Africa. Women are employed in the agricultural sector predominantly as self-employed farmers, unpaid labor on family farms, and paid or unpaid workers on farms owned by others [3]. Nigerian women are traditionally in charge of most of the agricultural labor in the homestead and are responsible for household food security and augmenting family incomes. According to [4], the number of women engaged in agriculture as a percentage of the economically active population in the South of Nigeria is roughly equal to that of men, with women constituting 51% of the agricultural labor force. Oil palm (*Elaeis guineensis*) is one of the most essential economic oil crops in Nigeria. Oil palm is indigenous to the Nigerian coastal plain though it has migrated inland as a staple crop [5]. The high demand for palm oil is making oil palm cultivation become a means of livelihood among many rural families, and indeed the farming culture of millions of people in Nigeria especially south.

Oil palm tree is a useful crop that is relevant in all aspects of life with socio-economic and socio-cultural values. Oil palm fruit processing involves harvesting, threshing or bunch quartering, fruit loosening, boiling, digestion, pressing/oil extraction, clarification and packaging/storage. Small-scale production of palm oil involves the use of traditional or semi-mechanized methods for oil extraction from the fresh fruit bunch. [6] observed two broad methods of palm oil processing, the traditional or manual method normally referred to as "low" technology and the mechanized or modern method of processing, basically the same principles as the present industrial method, the difference is the equipment and technology being employed and of course the quality of each method and it is common knowledge that the use of machine enhances productivity. They also stated that palm fruit can be processed by using the traditional method or more sophisticated method. In the industrial method, after harvesting the fruits in the groves or plantation, the fruit bunches are moved to the mill. Here the fresh fruit bunches are weighed and then quartered before they are moved to the sterilization unit where they are cooked.

After sterilization, the next step is stripping and threshing to separate the fruit from the husks. The husks are then discarded and later used as fuel for firing furnaces that power the sterilizer. The separated fruits are then moved to the digester where the cooked fruits are mashed into a pulp. The mash is moved to the presser from where the palm oil will be squeezed out and moved into a clarifier for sedimentation. Palm oil has always been processed by using traditional primitive rural technique of cooking the palm fruits in a pot and pounding the cooked fruits in a wooden mortar. The mash is then pressed either by hand or any other method which will squeeze the palm oil out of the mash.

[7] affirmed that majority of palm oil processors adopt traditional or semi mechanized technique of processing.

For rural women, this method is very tedious and laborious compared to mechanical methods and requires a substantial proportion of labour force. More so, it is observed that traditional methods of extracting palm produce are inefficient and tiresome. Traditional method of palm oil processing is arduous, time consuming and oil yield is usually low. Obviously, oil palm fruit processing activities are dominated by smallholders, especially women located in the rural communities of Nigeria.

This study therefore assessed women's involvement in palm oil processing in Ife-North Local Government Area Osun State, Nigeria. The specific objectives of the study were to describe the socio-economic characteristics of women involved in palm oil processing, determine the levels of women's involvement in palm oil processing in the study area and identify the constraints to involvement of women in palm oil processing in the study area. The study hypothesized that there is no significant relationship between the socio-economic characteristic of the women palm oil processors and their level of involvement in palm oil processing.

MATERIAL AND METHODS

The study was carried out in Ife North Local Government Area (LGA) of Osun State. Ife North local government area of Osun State shares boundary with Ife East, Ife Central and Ife South with its headquarter in Ipetumodu town. It is located between latitude 6^0 57'35" 7^0 34' 25" N and longitude 4^0 20'34" 7^0 34' 26" E. It has an area of 837km2 and a population of 153,274 (76,852 males and 76,422 females) [8]. A two-stage sampling procedure was used in this study. The first stage involved purposive selection of five wards out of the ten wards in the LGA due to high palm oil processing in the wards. The second stage involved random selection of five communities from each of the five wards. The third stage involved random selection of. 24 women palm oil processors from each of the communities to make a total of 120 women palm oil processors. Primary data were used in this study. The data were collected through the use of a well-structured interview schedule and were subjected to percentage, mean scores, and standard deviation as well as Chi-square analysis.

RESULTS AND DISCUSSIONS

Socio-economic characteristics

Results in Table 1 show that the mean age of the women palm oil processors was 50.2±15.173 years. This implies that most of the women were still young and agile. Palm oil processing requires the use of substantial amount of labour and able-bodied individuals. Being young could also make them to be eager to accept and implement new technologies on palm oil processing. This result agrees with the findings of [9] that majority of the respondents sampled were within the age of 26-50 years. The results further show that majority (73.3%) of the women palm oil processors were married. This indicates that the women palm oil processors had marital relationships and as such may have responsibilities. This result agrees with the findings of [10] that majority of the respondents sampled were married. Also, majority (68.3%) of the women palm oil processors in the study area had a household size between 3 and 5 persons and the mean household size was 5.13 (approximately 5) persons.

This implies that the women palm oil processors had marital relationships and as such may have responsibilities. It further implies that part of the products (palm oil) and proceeds (money) from palm oil processing can be utilized by the women palm oil processors to cater for their family members. This result agrees with the findings of [11] that half of sampled respondents had 1-5 household members.

In addition, the results further reveal that majority (55.0%) of the women palm oil processors had secondary education, some (15.0%) percent had primary education and 11.7% had tertiary education. This indicates that majority (81.7%) of the women palm oil processors had at least one form of education, implying that they may have the technical knowhow, apply modern processing techniques and may be ready to accept technology or innovations that can improve their processing standard. This result agrees with the findings of [12] that majority of the respondents sampled had one form of formal education or the other. The results further show that majority (74.2%) of the respondents were primarily palm oil processors, some (15.8 percent) were traders, few (9.2 percent) were artisans and few just one respondent (0.8 percent) was a farmer. This result agrees with the findings of [13] that the sampled respondents engaged in other occupations such as oil palm cultivation, vocational job, civil service, trading, and other crops farming.

The results further show that the mean years of experience was 24.7 years, implying that majority had been into palm oil processing for more than two decades. This result agrees with the findings of [14] who reported that the average years of experience of palm oil processors was 21.45 years. The results further show that majority (57.5%) of the women palm oil processors belong to an palm oil processing association. This result implies that most of the women palm oil processors belong to palm oil processing association and are expected to access some benefits from the association. This result disagrees with the findings of [15] which reported that palm oil fruit processors do not belong to association.

The results further show that more than half (55.8%) of the women palm oil processors come in contact with the extension agents once or twice in a production year. Visitation by extension agents should offer the women palm oil processors the opportunity to express various processing constraints encountered for which possible solutions may be proffered. This result implies that majority of the women palm oil processors may have had the opportunity to express various constraints encountered in palm oil processing to extension agents and solutions may have been proffered to such problems. This result agrees with the recommendation of [16] that the input of extension services is needed to motivate and encourage the palm oil entrepreneurs to visit relevant research institutes for latest innovation on processing methods and they should also be assisted in sourcing credits facility from relevant agencies to improve their production for better welfare system.

The results further show that all (100.0%) of the women palm oil processors use semi-mechanized method to process their palm oil. None usage of modern processing method/technology by the women palm oil processors may have been due to none availability/accessibility of improved processing method/technology in the study area. It may also be due to inadequate awareness/inability to adopt the improved processing method/technology on the part of the women palm oil processors in the study area.

The result implies that all the respondents used a combination of both traditional and modern methods in the processing of their palm oil produce.
The findings are in tandem with [17] that small- scale production involves the use of traditional or semi-mechanized methods for oil extraction from the fresh fruit bunch.

Table 1. Distribution of women palm oil processors according to their socio-economic
characteristics (n =120)__

Characteristics	Frequency	Percentage	Mean	Standard Deviation
Age (years)				
20-30	18	15.0		
31-60	69	57.5		
61-79	33	27.5	50.2	15.173
Marital status				
Single	6	5.0		
Married	88	73.3		
Separated	7	5.8		
Divorced	3	2.5		
Widowed	16	13.3		
Household size				
3-5	82	68.3		
6-10	37	30.8		
11-15	1	0.8	5.13	1.466
Educational qualification				
No formal education	17	14.2		
Adult literacy	5	4.2		
Primary	18	15.0		
Secondary	66	55.0		
Tertiary	14	11.7		
Primary occupation				
Palm oil processing	89	74.2		
Farming	1	0.8		
Artisanship	11	9.2		
Trading	19	15.8		
Years of experience				
3-10	25	20.8		
11-20	25	20.8		
21-30	31	25.8		
31-40	21	17.5		
41-50	18	15.0	24.71	13.670
Membership of palm oil processors' association				
Members	69	57.5		
Non- members	51	42.5		
Extension agent's visit				
Yes	67	55.8		
No	53	44.2		
Processing method				
Traditional	0	0.0		
Semi-mechanized	120	100		
Mechanized	0	0.0		

Source: Field survey, 2022.

Level of involvement in palm oil processing activities

Results in Table 2 show the extent of involvement of the sampled women in palm oil processing in descending order. Oil drying ranked 1st with a weighted mean score of ($\overline{x}$=3.87), next was oil packaging ($\overline{x}$=3.85), then, marketing ($\overline{x}$=3.83), oil clarification ($\overline{x}$=3.83), pressing ($\overline{x}$=3.83) and others in that order. This result supports the fact that oil drying, oil packaging, marketing, oil clarification and pressing of palm oil were seen as a woman's job. The result agrees with the findings of [18] and [19] that women were more prominent in palm oil extraction activities. The planting and the major cutting of ripe oil palm fruit bunches was left to the men as this was cumbersome and manly in nature. According to [20], males were involved in production of oil palm as cultivation/production activities and are more tedious which may be more compatible with men nature than for their women counterpart.

This means that from the above, the women palm oil processors were involved in almost all the processing activities except for bunch threshing. In other words, the women palm oil processors were mainly involved oil drying, oil packaging, marketing, oil clarification, pressing, digestion of fruit, oil storage, bunch sterilization, nut recovery and bunch reception. In addition, the results show that close to half (47.5%) of the women palm oil processors were at a medium level of involvement while some (41.7%) had high level of involvement and some, 10.8% of the women palm oil processors had a low level of involvement. The overall result implies that over 89.2% of the women palm oil processors had a medium level of involvement in each of the palm oil processing activities in the study area.

Table 2. Level of women's involvement in palm oil processing (n = 120)

Processing activities	Mean	Standard Deviation	Rank
Oil drying	3.87	0.448	1st
Oil packaging	3.85	0.381	2nd
Marketing	3.83	0.570	3rd
Oil clarification	3.83	0.473	4th
Pressing	3.83	0.443	5th
Digestion of fruit	3.79	0.447	6th
Oil storage	3.75	0.612	7th
Bunch sterilization	3.68	0.622	8th
Nut recovery	3.63	0.870	9th
Bunch reception	2.76	1.021	10th
Bunch threshing	1.00	0.000	11th
Levels of involvement	Frequency		Percentage
High (>40.8)	50		41.7
Medium (35 and 39)	57		47.5
Low (< 34. 7)	13		10.8
Total	120		100

Source: Field survey, 2022.
Mean = 37.82±3.07, High (Mean + SD) = ≥ 40.8.
Medium (Between high and low) = Between 35 and 39, Low (Mean – SD) = ≤ 34. 7.

Constraints to involvement of women in palm oil processing

Results in Table 3 show the constraints to women's involvement in palm oil processing. High cost of labour and transportation ranked 1st with a weighted mean score of ($\overline{x}$=3.04), next was poor transportation ($\overline{x}$=2.73), price instability ($\overline{x}$=2.58), poor information about the price ($\overline{x}$=2.57), aging palms and poor managerial ability ($\overline{x}$=2.37), lack of modern processing equipment ($\overline{x}$=2.36) and poor financial support ($\overline{x}$=2.15), seasonality of crop (2.04) and others in that order. This means that involving in palm oil processing in the study area is faced with constrains of high cost of labour and transportation, poor transportation, price instability and poor information about the price and others. This result agrees with the findings of [21] who found lack of credit facilities, high cost of labour, lack of processing machines, harvesting problem, high cost of processing and palm fruit scarcity constituted the major problems confronting women palm oil processors in the study area. This implies that any intervention that would be applied to enhance the women palm oil processors' involvement in palm oil processing in the study area should be applied to solve the identified constraints in ascending order.

Table 3. Constraints to women's involvement in palm oil processing (n = 120)

Constraints	Mean	Standard Deviation	Rank
High cost of labour and transportation	3.04	0.938	1st
Poor transportation	2.73	1.084	2nd
Price instability	2.58	0.837	3rd
Poor information about the price	2.57	0.959	4th
Aging palms and poor managerial ability	2.37	0.697	5th
Lack of modern processing equipment	2.36	0.776	6th
Poor financial support	2.15	1.281	7th
Seasonality of crop	2.04	0.824	8th
Instability of Government	1.77	0.965	9th
Inadequate communication system	1.73	1.020	10th
Poor marketing	1.67	0.822	11th
Problem of land acquisition	1.67	0.823	12th
Poor storage facilities	1.64	0.968	13th
Poor standard measure	1.48	0.830	14th

Source: Field survey, 2022

Relationship between the socio–economic characteristics of the women palm oil processors and level of involvement in palm oil processing

Results in Table 4 show the result for Chi-square analysis of association between some socio-economic characteristics of the women palm oil processors and their level of involvement in palm oil processing. The results show significant association between age (χ2=18.730, p=0.001), marital status (χ2=15.663, p=0.047), primary occupation (χ2=20.207, p=0.003), level of education (χ2=15.821, p=0.045), experience (χ2=16.607, p=0.034) and involvement in palm oil processing, therefore, the null hypothesis is rejected.

Age had a significant association with involvement in palm oil processing. This implies that involvement in palm oil processing varies among respondents with various age groups sampled for the study.

It also implies that the age of the respondents contributed to their involvement in palm oil processing. Marital status also had a significant association with involvement in palm oil processing. This implies that involvement in palm oil processing varies among respondents with various marital status sampled for the study. It also implies that the marital status of the respondents contributed to their involvement in palm oil processing. Primary occupation also had a significant association with involvement in palm oil processing. This implied that involvement in palm oil processing varies among respondents with various primary occupations sampled for the study. It also implies that the primary occupation of the respondents contributed to their involvement in palm oil processing. Level of education also had a significant association with involvement in palm oil processing. This implied that involvement in palm oil processing varies among respondents with various levels of education sampled for the study. It also implies that the level of education of the respondents contributed to their involvement in palm oil processing.

Experience in palm oil processing also had a significant association with involvement in palm oil processing. This implied that involvement in palm oil processing varies among respondents with various years of experience sampled for the study. It also implied that the years of experience of the respondents contributed to their involvement in palm oil processing. This result agrees with the findings of [22] that age, experience on the job, marital status, and household size were significant to the level of involvement in palm oil processing in the study area.

Table 4. Chi-square analysis showing the association between selected socio-economic characteristics of the women palm oil processors and involvement in palm oil processing (n=120)

Variables	χ^2 value	p-value	Decision
Age	18.730	0.001**	Significant
Marital status	15.663	0.047*	Significant
Religion	3.298	0.192	NS
Primary occupation	20.207	0.003**	Significant
Level of education	15.821	0.045*	Significant
Experience in palm oil processing	16.607	0.034*	Significant
Household size	1.489	0.829	NS
Family size	0.987	0.611	NS

Significant at 0.05 level
Source: Field survey 2022.

CONCLUSION AND RECOMMENDATIONS

Women palm oil processors were middle-aged, married, and had palm oil processing as their primary occupation. Age, marital status, primary occupation, level of education and experience influenced the women's involvement in palm oil processing.

The study recommends that extension agencies/agents should increase visitation to the women palm oil processors so as to intimate the women with improved palm oil processing technologies and assist in sourcing for credit facility from government and other relevant credit agencies to enhance the women's involvement in palm oil processing in the study area.

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FAKTORI KOJI UTIČU NA UČEŠĆE POPULACIJE ŽENA U PROCESU PRERADE PALMINOG ULJA ZA PODRUČJE LOKALNE SAMOUPRAVE IFE NA SEVERU DRŽAVE OSUN, NIGERIJA

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Apstrakt: Studija je procenila anagažovanost žena u preradi palminog ulja u oblasti lokalne samouprave Ife North, na severu države Osun u Nigeriji.

Višestepenom procedurom uzorkovanja odabrano je 120 žena prerađivača palminog ulja. Primarni podaci, prikupljeni uz pomoć dobro struktuiranog intervjua-ankete, analizirani su prema učestalosti, procentu, srednjoj vrednosti, standardnoj devijaciji i hi-kvadrat analizi. Rezultati pokazuju da je većina (73,3%) prerađivača palminog ulja bila u braku, sa prosečnom starošću od 50,2±15,173 godine i godinama iskustva u preradi palminog ulja u proseku 24,713+13,670.

Sušenje ulja, sa $\overline{x}$=3.87, rangirano je na prvom mestu od svih aktivnosti prerade u koje su ispitanici bili uključeni. Približno polovina (47,5%) žena prerađivača palminog ulja bila je na srednjem nivou angažovanosti u ovom procesu.

Visoka cena rada i transporta rangirana je na prvom mestu sa ponderisanim srednjom vrednosti $\overline{x}$ =3.04 kod svih ograničenja u koje su uključeni učesnici.

Postojala je značajna povezanost između starosti ($\chi2$=18.730, p=0.001), bračnog statusa ($\chi2$=15.663, p=0.047), osnovnog zanimanja ($\chi2$=20.207, p=0.003), nivoa obrazovanja ($\chi2$=15.821, p=0.045), iskustva ($\chi2$=16.607, p=0.034) kod učešća u preradi palminog ulja. Studija je zaključila da je među ženama bio srednji nivo angažovanosti u preradi palminog ulja.
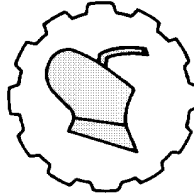
Preporučeno je da vladine i nevladine poljoprivredne agencije uvedu savremeni metod prerade palminog ulja (*Elaeis guineensis*) kao pomoć ženama angažovanim kao prerađivačima palminog ulja u oblasti istraživanja.

Ključne reči*: palmino ulje, prerada, žene, socio-ekonomska,ograničenja.*

DEVELOPMENT EXPERIMENT ANALYSIS OF VORTEX FORMATION

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Abstract: This developed a laboratory vortex apparatus with the aim to perform an experimental analysis of the formation of free and forced vortexes using water as fluid flow process. The experimental observations revealed that the apparatus surface of the vortex adjacent to the inner air core region was level where the radius expanded as the height increased. The orifice of the apparatus was selected for orifice diameters of 5, 10, 15, and 20mm at 30, 45, 60 and 90° angle of inclination were used to determine the diameter of the vortex developed for experimental flow process. The apparatus generated highest vortex diameter of 17mm for the free vortex and 8mm for forced vortex flow process a constant pressure head of 11.2m. Further analysis of the effect of orifice revealed that the larger the orifice diameter of 10, 15 and 20mm at developed a vortex faster for the two flow process as the angle of inclination was increased. The finding of this study will enhance further study to understand turbulent fluid flow process of vortex formation to meet demands of future technologies.

Keywords: *Orifice, vortex-diameter, tapping, radius, flow process.*

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INTRODUCTION

The wake of flow behind a bluff body has been a subject of interest to engineers as well as to scientists for many years now, and is imbedded in the knowledge and concept of vortex. The mathematical treatments of such flow were fundamental in the development of aero foil lift, fan/pump blade design and ground water flow predictions. The fluid mass rotates either due to fluid pressure, the gravity, or due to rotation or impact by an external force.

According to [6] the fluid rotates under certain energy previously given to them to form a flow pattern called vortex. The vortex is a connected region where the vector is not zero [7]. The concept of vortex formation in fluid mechanics is a special form of fluid motion featured as the rotation of fluid elements can be found in many fields of engineering application. Further, the study of natural phenomena such as hurricanes, tornadoes, and whirlpools require full understanding of vortex behavior.

The application of vortex flow theory can be found in aerodynamics in accelerating flows, where it is possible to see the flow as corresponding to an infinitely large Reynolds number and to zero viscosity. When these types of flow pattern revolve about the axis or are streamlined in concentric circles, they are known as vortex flows [17]. The flow patterns can be categorized under two main types: free and forced vortexes.

Free vortex motion is the type that occurs naturally in life, as it is independent of any external force or mechanical means for its occurrence. Any flow pattern whereby the streamlines are concentric and the fluid particles do not rotate about their axis while revolving around the vortex center is known as free or non-rotational vortex, and a vortex is a connected region where the vortex vector is not zero. However, the forced vortex theory relates to a fluid mass that was made to rotate under the action of an external force. The means of this rotation should be continuous and constant so that the entire fluid body will rotate at constant angular velocity.

According to [11], the difference between free and forced vortexes was as a result of the fluid viscosity at different high velocities of flow. Their study was to characterize the forced vortices generated in machineries, such as centrifugal pumps or turbines.

As the quest to study this phenomenon is limited by lack of equipment due to the complexity of the flow process, [2] developed a forced vortex experimental equipment laboratory use. Their experimental study of fluid flow phenomenon is a very important for engineering students and one of the equipment that can help to demonstrate forced vortex equipment. The mathematical treatment of such flow was fundamental in the development of enhanced aero foil lift systems, fan/pump blade design and ground water flow predictions. [8] further examined a Model to investigate a free surface vortex with particle tracking in different hydraulic turbo-machines; while [14], presented a portable apparatus to demonstrate a particular vortex known as bathtub vortex (BTV). According to them, this type of vortex occurs when water is drained from a hole at the bottom of a container such as a bathtub or a sink under the action of gravity. They further proposed a vortex mixer that employs centrifugal force for reagent mixing in the laboratories especially where there is a requirement for chemical or material analysis.

Additionally, [1] developed a Ferro-vortex apparatus which relates to devices for electro-mechanical processing of liquid, bulk and other blends that can be used in agriculture, medicine, chemical, oil and gas industry, communal services and other areas. Kumar [13] designed and fabricated a Low-Cost Vortex Mixer using additive manufacturing.

The equipment allows for the mixing of different reagents at different speeds. Subsequently, [18] carried out an experimental study of vortex induced vibration of a steel catenary riser under steady current. The vortex induced vibration (VIV) of marine risers has been investigated by many researchers in experimental studies of a straight flexible riser model as well as a rigid cylinder to reveal the dynamic response characteristic and the mechanics behind it. However, due to the limitation of experimental apparatus, very few studies are about the VIV of a steel catenary riser (SCR) which is with a complex geometry. The work done by [12], was optimized to improve energy conversion, and hence generate electricity from low water heads of between 0.7 m to 3m, using the commercial Computational Fluid Dynamics (CFD) code ANSYS Fluent, to investigate the optimum configuration of the vortex pool system by modeling the free surface flow mathematically. Consequently, from the available literatures and work done in this field of flow process, there is need to further study and gain full understanding of vortex behavior as a result of the impact of natural phenomena such as hurricanes, tornadoes, and whirlpools free developed vortices to the environment. Although with the latest vortex flow equipment developed by [5] that made use of vorticity to calculate the force exerted by a developed forced vortices for mixed fluids at different fluid velocities using the "Von Kármán" effect principle; this paper will present a developed vortex apparatus used to perform experiments analysis of a flow process through different orifices placed at different angle of inclination to analyze the rate of vortex development and further comparative analysis of the developed free and forced vortexes.

MATERIAL AND METHODS

Development of the experimental vortex apparatus

The concept of the vortex apparatus was to design the supply of water or other fluids across an impeller and discharge through an orifice at the center bottom of a cylindrical vessel. The aim to generate a vortex as a result of the effect of the fluid flow on the rotation of the impeller attached in the cylindrical vessel through the discharge diameter of the orifice. The apparatus consist of the Hydraulic bench, cylinder vessels, valves, pipes, push-in orifice, impeller, and electric pump, while the material used was water source able from a reservoir.
The main frame was constructed of the isometric design and dimensions shown in Fig 1.1a and 1.1b using 2inches mild steel bar angle. The cylindrical vessel has a perforation at the center bottom that can be varied to 24mm diameter.
It also has four overflow openings 155mm by 65mm at the top with a hanging scale rule that helps to measure the water level. An electric pump was used to continuously supply fluid flow from the reservoir back to the cylinder vessel through a 20mm input pipe. The impeller for forced vortex experiment is constructed with acrylic plastic glued to a 20mm diameter cylindrical shaped pipe of height 35 mm that can be inclined at various angles. The orifices used were designed to be interchangeable at different diameter sizes, and attach to the exit center bottom of the cylinder vessel.
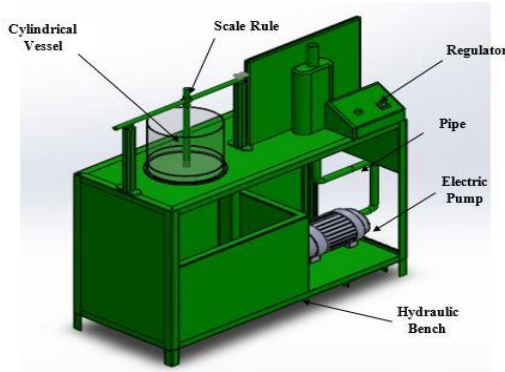
Fig 1.1a. Isometric design of the vortex app.   Fig. 1.1b. Dimensions of the design vortex app.

2.2.Experimental Procedures for the Developed of Vortex

The procedures for conducting the experimental flow process to develop the free and forced vortexes were the same.

The experimental procedures were initiated by Position the apparatus on the hydraulics bench so that the central outlet in the base of the vessel is located over the weir trough; the push the required orifice diameter into the central outlet located in the base of the apparatus. Connect the inlet pipe of the apparatus (situated on the 3-way valve) to the hydraulics bench outlet, using the flexible pipe provided.; thereafter close the apparatus outlet globe valve and position the 3-way valve so that water flows into the vessel via the 15-degree inlet ports. Close the bench outlet valve, and gradually open the bench valve, and allow the vessel to fill with water until water overflow through the cutouts. After the vessel was slightly overflowing, slowly open the outlet valve so that the water level maintains a stable height. After a constant water level has been achieved, the water surface profile was measured by adjusting the measuring caliper to the desired radius by lowering the caliber into the vortex until the needles evenly touch the walls of the vortex. Subsequently, the pressure depth was also recorded. For the forces vortex, an external force was imparted by an impeller that was powered by an electric motor. This impeller sets the flow process into motion and moves until the velocity at which the fluid moves equals that of the impeller. These procedures were repeated for different orifice diameters at different angles of inclination for the developed free and forced vortexes where the velocity of circulation, pressure head and time of the development for every experimental procedure were measured and calculated respectively.

2.3. Calculated Flow Parameters for the Developed Vortex

The Reynolds number was determined in equation (1);

$$R_e = \frac{\rho v d}{\mu} \qquad \qquad \text{.........................(1)}$$

Where, Re = Reynolds number,
ρ = density of water, kgm^{-3},
d = diameter of the cylinder,

m, v = linear velocity of flow in the cylinder, ms^{-1}, and μ = dynamic viscosity, Nsm^{-2}

The rate of water flow through the pipe for the various angles of inclination of different orifice diameters was derived using equation (2) for given the depth-discharge relationship that is independent of the pipe length for partly full flow [12].

$$Q_w \propto g^{\frac{1}{2}} h^{\frac{1}{2}} d^2 \qquad\qquad\qquad \text{………\ ………...……….\ (2)}$$

Where;

$$Q_w = C_d g^{\frac{1}{2}} h^{\frac{1}{2}} d^2 \qquad\qquad\qquad \text{…………….…….…..\ (3)}$$

C_d is a dimensionless coefficient of this charge,
Q_w is the water discharge, m^3.s^{-1},
g is the gravitational acceleration, m.s^{-2},
h is the approach flow depth, m,
Q is the bulk discharge.

The effects of viscosity in vortex flows presented by [19] revealed that an increase in the viscous shear across the impeller increased the development of the vortex; hence, the coefficient of discharge can be determined as follows:

$$C_d = 0.686 - 0.218 N_v \qquad\qquad \text{……….……………….…...\ (4)}$$

Where, N_v is the vortex velocity

$$N_v = \frac{d\sqrt{2gh}}{\Gamma_\infty} \qquad\qquad\qquad \text{………………….…..(5)}$$

Where the vortex rate of formation in seconds, Γ_∞ by Anwar (2018) was determined using equation (6)

$$\Gamma_\infty = Q \Big/ {\frac{5}{d^2}\sqrt{g}} \qquad\qquad\qquad \text{…..\ …...…………\ (6)}$$

RESULTS AND DISCUSSION

Effect of Orifice Sizes

The experimental observation showed that when the orifice diameter was increased, the diameter of the developed vortex increased. Subsequently, it was revealed in Fig. 2.1., that the apparatus generated highest vortex diameter of 17mm with the widest orifice of 20mm. The experimental process for the free vortex experiments revealed a progression change of the increment at a constant pressure head of 11.2m for the used orifices and the developed vortex respectively. Hence, the orifice sizes of 5, 10, 15, and 20mm produced the diameter of the developed vortexes of 3, 7 12 and 17mm of the flow process at 11.2m pressure head P_h, where the diameter of the generated vortex was smaller than the orifice diameter. Further, the Re value of flow for the experimental processes for the free vortex formation was calculated to be above 2000.

The force vortex experimental processes revealed the formation of 8mm vortex as the highest vortex with the widest orifice diameter of 20mm. As shown in Fig. 2.2., the diameter of the generated vortex increased as the result of the increase in the size of orifice diameter; however, at 5mm orifice diameter, no vortex was formed. Further, the calculated Re value for the forced vortex experimental procedure was calculated to be below 2000. Comparative analysis of two experiments revealed that a larger vortex was developed for the free vortex process than the forced one at a constant pressure head of 11.2m.
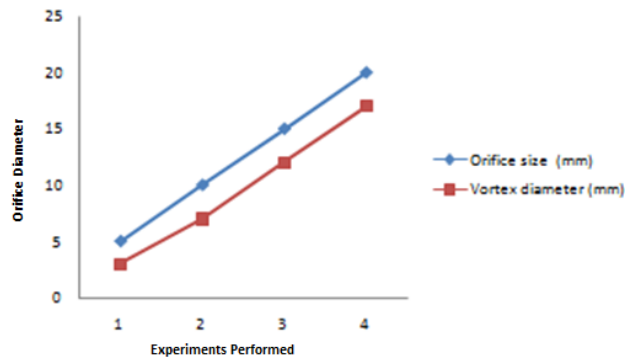
Fig. 2.1. Effect of orifice size to the diameter of the vortex using free vortex apparatus
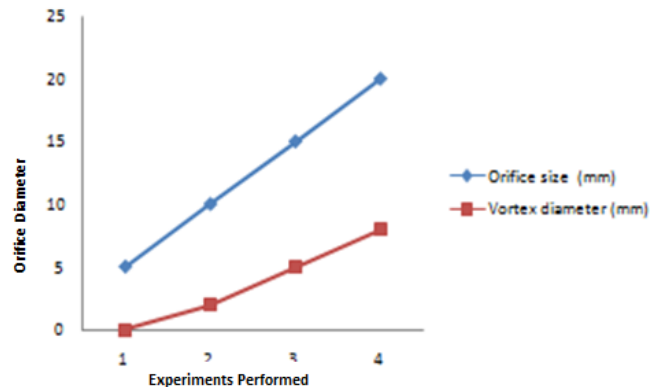
Fig. 2.2. Effect of orifice size to the diameter of the vortex using force vortex apparatus

3.2 Effect of the Orifice Diameter and Angle of Inclination

The rate of vortex generation for the different angle of inclinations of the used orifice sizes were shown in Fig. 2.3., and 2.4., for the free and forced experimental processes using 5, 10 15 and 20mm orifices inclined at 30, 45, 60 and 90° respectively.
The vortex developed fastest for the flow process for the two processes for the 20mm diameter orifice inclined at an angle of 90°.
The experimental observation results shown in Fig 2.3., revealed that the larger 10, 15, 20mm diameter of orifices at all angle of inclination developed faster than the 5mm.

This was due to the orifices size reduced the rate of water discharged from the experimental apparatus and thereby producing the vortex faster. This observation was clearly observed when no vortex was developed for the flow process for 5mm diameter orifice at 90°. Subsequently, it can be deduced that the larger the orifice diameter of 10, 15 and 20mm, the faster the development of their respective vortexes. Resultantly, as the angle of inclination of the vortex increased the faster the rate of development of the vortex.
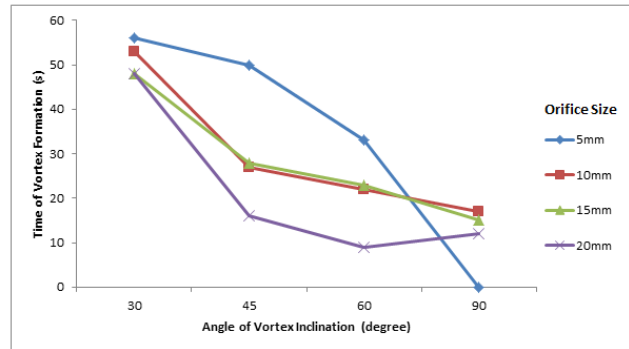
Fig.2.3. Effect of the Orifice size to the Diameter and Angle of Vortex Inclination (90°)

However, next Fig 2.4., showed the flow process developed the fastest vortex using an orifice of 5mm, inclined at an angle of 45°. This was as a result that the rate at which the inclination discharge rotates or turn the water inside the cylinder, reducing the rate of water been discharged from the created center hole within the cylinder. At a higher orifice diameter of 15 and 20mm, the vortex development was slow and took a longer time to form. However, there was no vortex formed for smaller orifice diameters at 90°. Evidently, the vortexes formed during free flow process were slower to develop compared to forced due to the effect of the forced impeller in the latter. Also, as the diameter of orifices was increased for the forced flow process, the rates of vortex development were faster; and reverse result for the free flow process. Additionally, the higher the angle of inclination of the orifice, the faster the rate of formation of the vortex for the two flow process.
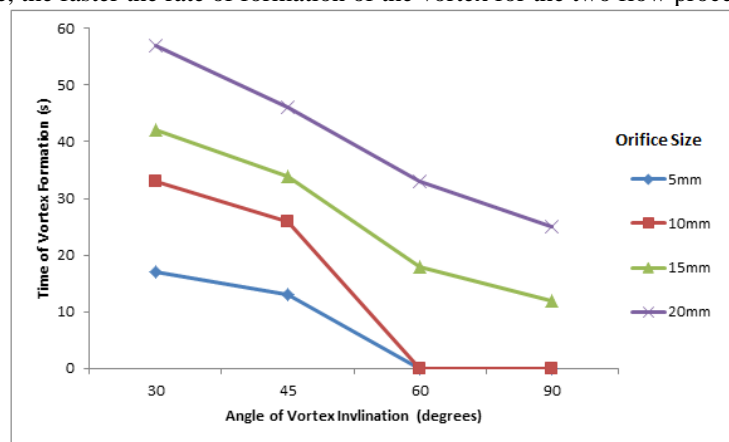
Fig. 2.4. Effect of the Orifice size to the Diameter and Angle of Vortex Inclination (60° and 90°)

CONCLUSIONS

The vortex apparatus was designed to perform the experimental procedures for the development of the free and the forced vortex respectively. The results of the experimental processes revealed that the surface of the vortex adjacent to inner air core region was height (level of water) dependent.

Also, the vortex radius increased as the height increased, however the higher the value of the vortex radius obtained for same values of height though profile pattern is invariable. Subsequent experimental observations showed that the pressure head increased with reducing free vortex radius; where the tangential velocity was found to be inversely proportional to radius of vortex as the circulation along vortex relatively remained at constant value. Further, the increase in the orifice diameter sized and angle of inclination was revealed to increase the rate of formation of the vortex for the two flow process.

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RAZVOJNI EKSPERIMENT ANALIZE FORMIRANJA VRTLOGA

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Apstrakt: Ovim istraživanjima je razvijen laboratorijski (mixer) aparat za vrtlog sa ciljem da se obavi eksperimentalna analiza formiranja slobodnih ili prinudnih vrtloga sa korišćenjem vode kao procesa u strujanju fluida. Eksperimentalna zapažanja su otkrila da je površina aparata za vrtlog u blizini unutrašnjeg vazdušnog jezgra bila u nivou gde se radius širio kako se visina povećavala. Aparat (mixer) je odabran sa prečnicima od 5, 10, 15 i 20 i 30 mm.

Uglovi nagiba od 45º, 60º i 90º su korišćeni za određivanje prečnika vrtloga razvijenog za eksperimentalni proces strujanja fluida.

Aparat je generisao najveći prečnik od 17 mm za slobodni vrtlog, i 8 mm za proces sa prinudnim vrtložnim strujanjem, sa konstantnim pritiskom od 11,2 m.

Dalja analiza uticaja otvora otkrila je da što je veći prečnik otvora od 10, 15 i 20mm pri tome razvijao vrtlog brže za proces sa dva protoka kako se povećavao ugao nagiba.

Rezultati ove studije poboljšavaju dalje proučavanja kako bi se razumeo proces formiranja vrtloga turbulentnog protoka fluida da se zadovolje zahtevi budućih tehnologija.
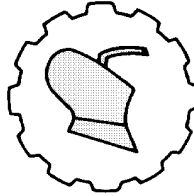
ULOGA I ZNAČAJ SISTEMA ZAŠTITE DECE KAO PUTNIKA U VOZILU, ANALIZA BEZBEDNOSTI DECE U DEČIJIM SEDIŠTIMA

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Sažetak: Deo sistema pasivne bezbednosti unutar vozila su i bezbednosna sedišta za decu. U radu je objašnjena uloga i značaj bezbednosnih sedišta za decu u zaštiti mlađe populacije dece putnika u vozilu prilikom saobraćajne nezgode, odnosno sudara vozila.

Takođe, u radu su dati rezultati pojedinih istraživanja o doprinosu dečjih bezbednosnih sedišta u zaštiti dece prilikom sudara, u zavisnosti od pozicije u vozilu i vrste nezgode.

Iz razloga bezbednosti, propisano je da se deca starosti do 12 godina mogu prevoziti samo na zadnjim sedištima. Ova obaveza predviđena je zato što zadnja sedišta pružaju najbolju kombinaciju sigurnosnih elemenata za putnike ovog uzrasta. Izuzetno, na prednjem sedištu mogu se prevoziti samo deca starosti do tri godine, pod određenim, strogo propisanim uslovima.

Nekorišćenje sistema zaštite za decu u automobilu u direktnoj je vezi sa stradanjem i težinom posledica u slučaju saobraćajne nezgode. Brojna istraživanja pokazuju da pravilna upotreba bezbednosnih sedišta za decu, značajno smanjuje rizik od zadobijanja teških povreda i smrtnog stradanja dece kod sudara ili prevrtanja vozila.

Ključne reči: *Dečje sedište, vozilo, bezbednost, rizik, stradanje, saobraćajna nezgoda, korelacija.*

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UVOD

Sigurosni sistem vozila je deo sistema pasivne bezbednosti vozila i sastoji se od više elemenata koji doprinose većoj zaštiti vozača i putnika u vozilu. Najvažniji elementi ovog sistema su:

• dizajn strukture vozila (spolja i unutra);

• sigurnosni pojasevi za fiksiranje položaja vozača i putnika u vozilu, odnosno ograničavanje njihove pokretljivosti u slučaju naglog kočenja ili sudara;

• bezbednosna sedišta i drugi sistemi zaštite dece u vozilu;

• vazdušni jastuci;

• nasloni za glavu.

Navedeni sistemi zaštite (sigurnosni pojasevi, vazdušni jastuci i bezbednosna sedišta za decu), pored osnovne funkcije zaštite, pomažu u održavanju ispravnog položaja putnika, odnosno dece u vozilu u slučaju sudara, što je dodatni elemenat zaštite i smanjenja posledica nezgode.

U srpskom zakonodavstvu ova oblast je uređena Zakonom o bezbednosti saobraćaja na putevima [1] i Pravilnikom o podeli motornih i priključnih vozila i tehničkim uslovima za vozila u saobraćaju na putevima. [2]

Prema ovom Zakonu deca starosti do 12 godina mogu se prevoziti samo na zadnjim sedištima. Zakonodavac je predvideo ovu obavezu iz razloga što zadnja sedišta pružaju najbolju kombinaciju sigurnosnih elemenata za putnike do 12 godina starosti, a na prednjem sedištu samo za decu do tri godine starosti, pod određenim uslovima.

Sedenje na prednjem sedištu dece mlađe od 12 godina povećava rizik od stradanja kod čeonih sudara, kako zbog deformisanja vozila prilikom sudara, tako i zbog jačine udara vazdušnog jastuka prilikom njegovog aktiviranja, što može da dovede do teških povreda i stradanja. Ovo tim pre što deca često ne sede mirno i ne znaju koliko je važno da u svakom trenutku budu u ispravnom položaju na sedištu, naslonjeni i pravilno vezani. Otuda je velika verovatnoća da će dete koje sedi napred biti u nepravilnom položaju, bliže instrument tabli, nagnuto napred ili bočno i sa nepravilnom pozicijom zaštitnih pojaseva, što sve zajedno dovodi do smanjenja efekata sistema zaštite.

ULOGA I ZNAČAJ DEČJIH BEZBEDNOSNIH SEDIŠTA

Imajući u vidu da je zadnji deo kabine vozila (zadnja sedišta) najbezbedniji za prevoz dece, ovaj prostor se u stručnoj literaturi često naziva „dečja zona". Ova zona je najviše udaljena od tačke udarca kod čeonih sudara, kao najčešće vrste saobraćajnih nezgoda. Ovo potvrđuju i rezultati istraživanja sprovedenih u SAD o posledicama saobraćajnih nezgoda sa učešćem dece, prema kojima deca putnici koji sede u bezbednosnom sedištu pozadi, u sredini, imaju 43% manji rizik od povreda nego deca sa sedištem u jednom od zadnjih bočnih položaja. [3]

Studija saobraćajnih nezgoda sa smrtnim posledicama u SAD koje su se dogodile u periodu od 2000. do 2003. godine potvrdila je da je osoba koja sedi u centralnom delu zadnjih sedišta, uz korišćenje sigurnosnih pojaseva, najbezbednija i ima 13% veću šansu da preživi u slučaju sudara u odnosu na osobe koje sede bočno pozadi. [4]

Ovo podrazumeva da dečje sedište odgovara toj poziciji u vozilu i sistemu sigurnosnih pojaseva, odnosno da je proizvođač vozila predvideo mogućnost montaže odgovarajućeg dečjeg bezbednosnog sedišta na toj poziciji.

Slika 1. Najbezbednije mesto za dečje sedište je na sredini zadnjih sedišta, [13].
Figure 1. The safest place for a child seat is in the middle of the back seats, [13].

U svrhu zaštite bezbednosti dece i eliminisanja određenih opasnosti, kao što je ispadanje deteta iz vozila i dr., savremeni putnički automobili imaju odgovarajuće zaštitne brave na zadnjim vratima kojima se sprečava mogućnost da dete otvori vrata sa unutrašnje strane i ispadne iz vozila u toku vožnje.

Takođe, većina automobila danas ima ugrađen glavni prekidač koji kontroliše otvaranje svih prozora, tako da vozač može da isključi nezavisno otvaranje prozora na zadnjim sedištima. Ovim se sprečava mogućnost da deca samostalno otvaraju prozore pozadi, proviruju „izbacujući" glavu ili pružaju ruke van vozila, što može dovesti do tragičnih posledica.

Prema izveštajima Svetske zdravstvene organizacije (World Health Organization - WHO) i Dečjeg fonda Ujedinjenih nacija (United Nations Children's Fund - UNICEF), povrede u drumskom saobraćaju su vodeći uzrok smrti kod mladih uzrasta od 15 do 19 godina i drugi vodeći uzrok smrti kod dece uzrasta od 5 do 14 godina, [5].

U Republici Srbiji deca čine oko 2% poginulih i 5% teško povređenih lica, odnosno oko 7% nastradalih lica. Javni rizik stradanja dece u saobraćajnim nezgodama je oko 12, što znači da na milion dece njih 12 izgubi život u saobraćajnim nezgodama, što je znatno više u odnosu na prosek zemalja EU, gde javni rizik stradanja dece ima vrednost 6,8. [6].

U poslednjih 10 godina (2013-2022) u Republici Srbiji u proseku, godišnje, život je gubilo oko 12, dok je povrede zadobilo oko 1.360 dece (oko 170 teže povređene i 1.190 lakše povređene dece) u saobraćajnim nezgodama. Drugim rečima, u proseku svakog meseca jedno dete pogine i nešto više od 110 dece bude povređeno u saobraćajnim nezgodama, [6].

Telo deteta je osetljivije nego telo odraslog čoveka i može da podnese znatno manje sile. Ispravno vezana deca u dečjim sedištima koja su pravilno postavljena izložena su znatno manjim silama u toku sudara i imaju znatno veće šanse za preživljavanje.

Upotreba sistema pasivne zaštite kod dece zbog toga često predstavlja granicu između života i smrti, [7].

Imajući u vidu da u okviru sistema zaštite dece putnika u vozilu, sigurnosni pojasevi ne pružaju adekvatnu zaštitu maloj deci, posebno mlađoj od tri godine, njihovu zaštitnu ulogu preuzimaju bezbednosna sedišta za decu koja značajno doprinose smanjenju broja smrtnih slučajeva i povreda dece u saobraćajnim nezgodama.

Prema istraživanjima u SAD o povredama dece u motornim vozilima u sobraćajnim nezgodama, u kojima su analizirani podaci o saobraćajnim nezgodama i posledicama za tri starosne grupe dece (do jedne godine, od 1 do 3 godine i od 4 do 7 godina), u zavisnosti od vrste nezgoda, utvrđeno je sledeće:

• najteže posledice kod sve tri starosne grupe imale su nezgode sa prevrtanjem vozila;

• kod prevrtanja vozila, rizik od teških povreda kod dece koja nisu bila vezana je tri puta veći u odnosu na decu koja su koristila sigurnosne pojaseve i osam puta veći u odnosu na decu koja su koristila bezbednosna sedišta;

• povrede glave bile su najčešće kod dece povređene u sudarima motornih vozila, a najčešće povrede glave bile su kontuzija i posekotine;

• deca mlađa od jedne godine češće su imala povrede glave u odnosu na druge dve starosne grupe,[8].

U pogledu traumatskih povreda mozga i neuropsiholoških problema, zaključak u ovoj studiji je da se posledice doživljene nezgode mogu javiti i znatno kasnije, zbog čega je neophodno pažljivo praćenje tokom odrastanja deteta.

Korišćenje sistema zaštite povezano je sa nivoom rizika od nastanka posledica saobraćajne nezgode. Deca koja ne koriste sisteme zaštite izložena su veoma velikom riziku od stradanja u slučaju saobraćajne nezgode. Ovi rizici se vezuju za mogućnost nastanka lakih i teških povreda, kao i smrtnog ishoda.

Veliki problem predstavlja i pojava da deca koriste sisteme zaštite u vozilu koji ne odgovaraju njihovim fizičkim katakteristikama, odnosno uzrastu. Optimalan sistem zaštite za decu, koji odgovara njihovom uzrastu, dokazano je da smanjuje rizik od nastanka povreda i smrtnog ishoda, [9].

Zablude kod roditelja igraju najznačajniju ulogu u neodgovarajućem prenošenju znanja i izgradnji pozitivnih stavova o značaju upotrebe sistema zaštite kod dece, [10]. Zbog toga je neophodno vršiti konstantnu edukaciju roditelja kako bi se obezbedilo da deca koriste sisteme zaštite koji odgovara njihovom uzrastu, [10].

Korišćenje sigurnosnih pojaseva kod vozača utiče na korišćenje sistema zaštite kod dece putnika u vozilu,[11]. Korišćenjem sistema zaštite u putničkim automobilima smanjuje se rizik od smrtnog stradanja za 71% kod male dece starosti do jedne godine i do 54% kod dece uzrasta od 1 do 4 godine, [12].

UTICAJ KORIŠĆENJA BEZBEDNOSNIH SEDIŠTA ZA DECU NA BEZBEDNOST DECE U VOZILU

Dete starosti do 3 godina, osim na zadnjim sedištima, može se prevoziti i na prednjem sedištu, ukoliko se prevozi u bezbednosnom sedištu – korpi, koja je okrenuta suprotno smeru kretanja vozila, kada vozilo nema ili je isključen bezbednosni vazdušni jastuk.

Imajući u vidu značaj sistema zaštite dece putnika u vozilu, posebno bezbednosnih sedišta za decu, izvršena je i analiza uticaja, odnosno doprinosa upotrebe bezbednosnih sedišta za decu uzrasta do 3 godine, njihovoj bezbednosti u vozilu.

Analiza je korelacionom analizom podataka, da bi se utvrdila međuzavisnost, veza između procenta korišćenja zaštitnih sistema (dečjih sedišta) za decu putnike starosti do 3 godine i njihovog stradanja u saobraćajnim nezgodama u R.Srbiji, na godišnjem nivou, u periodu od 2013. do 2022. godine, [13].

Korelaciona analiza pokazuje stepen zavisnosti između promenljivih, odnosno korelacijom se meri jačina već utvrđene povezanosti između dve promenljive. Stepen intenziteta povezanosti između promenljivih, koje su u linearnom odnosu meri se:

- kovarijansom kao apsolutnom merom intenziteta korelacije, i
- koeficijentom proste linearne korelacije, kao relativnom merom intenziteta korelacione veze.

Tabela 1. Vrednosti (%) korišćenja bezbednosnih sedišta za decu uzrasta do 3 godine (nezavisna promenljiva X) i stradanja dece u vozilu (poginuli i teško povređeni - zavisna promenljiva Y), u periodu od 2013. do 2022. g. za potrebe korelacione analize
Table 1. Values (%) of the use of safety seats for children under 3 years of age (independent variable X) and injuries of children in the vehicle (killed and seriously injured - dependent variable Y), in the period 2013 - 2022 for correlation analysis

Godina Year	(%) Upotr. dečj. sedišta (0-3 g) (X)	Broj POG i TP dece u PA (0-3 g) (Y)	XY	X²	Y²	X-Xsr	Y-Ysr
2013	32	13	416	1024	169	-20	2
2014	34	13	442	1156	169	-18	2
2015	44	16	704	1936	256	-8	5
2016	40	17	680	1600	289	-12	6
2017	48	9	432	2304	81	-4	-2
2018	60	8	480	3600	64	8	-3
2019	61	10	610	3721	100	9	-1
2020	62	9	558	3844	81	10	-2
2021	69	9	621	4761	81	17	-2
2022	71	6	426	5041	36	19	-5
ZBIR	521	110	5369	28987	1326	1	0
	Xsr=52	Ysr=11	XsrYsr=572	Xsr²=2704	Ysr²=121	-	-

Kovarijansa (Sxy) predstavlja zajedničku meru varijabilnosti jedne i druge varijable (*x;y*), pa se matematički može predstaviti kao zbir varijansi jedne i druge varijable:

$$C_{xy} = SD_x^2 + SD_y^2 \qquad SD_x^2 = \frac{\sum\left(x - \bar{x}\right)^2}{n} \qquad SD_y^2 = \frac{\sum\left(y - \bar{y}\right)^2}{n}$$

$$C_{xy} = \frac{\sum\left(x - \bar{x}\right)^2}{n} + \frac{\sum\left(y - \bar{y}\right)^2}{n}$$

Radna formula za kovarijansu je predstavljena sa:

$$C_{xy} = \frac{\sum xy}{n} - \bar{x}\,\bar{y}$$

n = 10

SDx=14   SDy=3,4   Cxy= - 35,1

$$b = \frac{Cxy}{SDx} = -0,2 \quad a = \bar{y} - b\,\bar{x} = 21,4$$

y = bx + a (regresiona jednačina)

y = - 0,2x + 21,4   (regresiona jednačina)

$$rxy = \frac{Cxy}{SDx\ SDy} = -0,74$$

rxy = - 0,74 (koeficijent korelacije)   Rxy = rxy² = 0.55 (koeficijent determinacije)
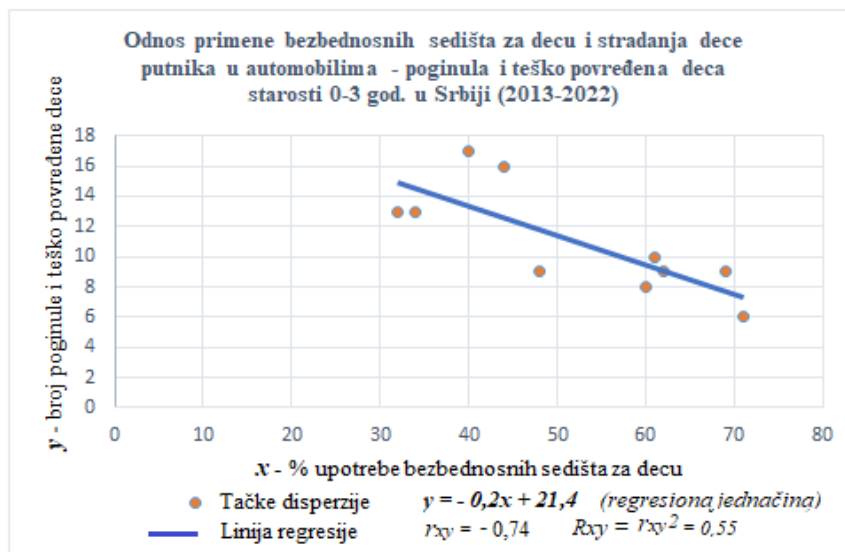
Graf. 1. Dijagram rasipanja dobijenih varijabli i regresiona linija, sa regresionom jednačinom
i vrednostima koeficijenata korelacije i determinacije
Graph 1. Scatter diagram of obtained variables and regression lines, with regression equation
and values of correlation and determination coefficients

Negativan predznak (-) ukazuje na negativnu povezanost varijabli. Porast jedne
varijable praćen je smanjenjem druge varijable, i obrnuto.

U ovom slučaju povećanje korišćenja bezbednosnih sedišta za mlađu populaciju dece doprinosi smanjenju njihovog stradanja kod saobraćajnih nezgoda, i obrnuto, što je osnova glavne hipoteze u ovom radu (Ho).

Testiranje koeficijenta proste linearne korelacije zasniva se na Studentovoj raspodeli za n-2 stepena slobode, za dobijenu *t-vrednost*. Test je matematički definisan formulom:

$$t = r_{xy} \frac{\sqrt{n-2}}{\sqrt{1-r_{xy}^2}}$$

gde je:

r_{xy} – dobijena vrednost iz uzorka; (r_{xy} = - 0,74)

n – veličina uzorka (broj parova); (n = 10)

t = - 3,126

Број степени слободе се израчунава по обрасцу: SS = n-2 = 8

Dobijena **t** – vrednost se tumači na isti način kao i kod klasičnog Studentovog **t**-testa.

(1) Testiranje dobijene vrednosti koeficijenta korelacije (r_{xy} = - 0,74) za 10 parova promenljivih, tj. vezu između procenta korišćenja zaštitnih sistema (dečjih bezbednosnih sedišta) za decu putnike starosti do 3 godine i broja poginule i teško povređene dece putnika u automobilima u saobraćajnim nezgodama u R.Srbiji u periodu od 2013. do 2022. godine.

Za osnovnu hipotezu (Ho´) ne postoji uzajamna zavisnost posmatranih varijabli, dok za alternativnu hipotezu (Ha´) ta zavisnost postoji.

(1) Ho´: r_{xy} (osnovnog skupa) = 0 (ne postoji uzajamna zavisnost);

(2) Ha´: r_{xy} (osnovnog skupa) ≠ 0 (postoji uzajamna zavisnost).

t = 3,126 > t(10 i 0,05) = 2,306 и p <0,05

Kako je dobijena (apsolutna*)* t-vrednost od 3,126 veća od granične tablične vrednosti t=2,306 za broj stepeni slobode 8 i prag značajnosti p=0,05 (prema Studentovoj raspodeli), to odbacujemo nultu (Ho´) hipotezu i prihvatamo alternativnu (Ha´) hipotezu, sa greškom: p<0,05 i pouzdanošću (verovatnoćom) P>95%.

Zaključak (1) je da između procenta korišćenja zaštitnih sistema (dečjih bezbednosnih sedišta) za decu putnike starosti do 3 godine i broja poginule i teško povređene dece putnika u automobilima u saobraćajnim nezgodama u R.Srbiji u periodu od 2013. do 2022. godine, postoji značajan stepen korelacije.

(2) Testiranje dobijene vrednost za r_{xy} = - 0,74 za t =8 i prag značajnosti p=0,02.

t = 3,126 > t(8 i 0,02) = 2,896 i p <0,02

Kako je dobijena (apsolutna) t-vrednost od 3,126 veća od granične tablične vrednosti t=2,896 za broj stepeni slobode 8 i prag značajnosti p=0,02 (prema Studentovoj raspodeli) to odbacujemo nultu (Ho´) hipotezu i prihvatamo alternativnu (Ha´) hipotezu, sa greškom: p<0,02 i sigurnošću (verovatnoćom) P>98%.

Uz napomenu da se radi o malom uzorku, zaključak (2) je da između procenta korišćenja zaštitnih sistema (dečjih bezbednosnih sedišta) za decu putnike starosti do 3 godine i njihovog stradanja u saobraćajnim nezgodama u putničkim automobilima u R.Srbiji u periodu od 2013. do 2022. godine, postoji visok stepen korelacije, sa verovatnoćom P>98%, a dobijena vrednost koeficijenta korelacije (r_{xy}=- 0,74) predstavlja realnu meru korelacije i uzročno posledične veze.

Pirsonov koeficijent korelacije daje informacije da li je povezanost varijabli slaba, umerena, jaka ili veoma jaka, ali nam ne daje i informaciju koliko je zavisna promenljiva uslovljena vrednostima nezavisne promenljive, a koliko drugim faktorima.

Ovaj problem rešava koeficijent determinacije, koji se izračunava kao drugi stepen koeficijenta proste linearne korelacije i on je mera za objašnjeni varijabilitet. Koeficijent determinacije (r_{xy}^2) predstavlja proporciju zajedničkog varijabiliteta dve posmatrane varijable.

U ovom slučaju koeficijent determinacije iznosi $r_{xy}^2 = 0,55$ što nam pokazuje da su u posmatranom periodu utvrđene vrednosti stradanja dece putnika u automobilima u saobraćajnim nezgodama (poginuli i teško povređeni) sa 55% uslovljene nivoom korišćenja zaštitnih sistema (dečjih bezbednosnih sedišta) za decu putnike starosti do 3 godine. Ostatak od 1 je koeficijent alijenacije: $1 – r_{xy}^2 = 1 - 0,55 = 0,45$ tj. utvrđene vrednosti stradanja dece putnika u automobilu sa 45% uslovljene su drugim faktorima, što predstavlja meru za neobjašnjeni varijabilitet (specifična vrsta nezgode, veće sudarne brzine, neodgovarajuće bezbednosno sedište za uzrast deteta, nepravilno postavljeno bezbednosno sedište, aktiviran vazdušni jastuk, požar u vozilu nakon nezgode i dr.).

Ovom korelacionom analizom, odnosno izvršenim testiranjima, i pored malog uzorka, sa velikom pouzdanošću je potvrđeno da se sa većim korišćenjem dečjih bezbednosnih sedišta kod mlađe populacije dece (0 do 3 godine), značajno doprinosi smanjenju njihovog stradanja u svojstvu putnika u automobilima, odnosno njihovoj većoj bezbednosti u slučaju saobraćajne nezgode, što je suština glavne hipoteze u ovom radu (Ho). Drugim rečima, ne postoje parametri na osnovu kojih bi se glavna hipoteza u ovom radu (Ho) mogla odbaciti.

ZAKLJUČAK

Bezbednosna sedišta za decu su deo sigurosnog sistema koji doprinose većoj zaštiti mlađe populacije dece kao putnika u vozilu. Brojna istraživanja pokazuju da pravilna upotreba bezbednosnih sedišta za decu, značajno smanjuje rizik od povreda i smrtnog stradanja dece u saobraćajnim nezgodama, posebno kod direktnih sudara i prevrtanja vozila. S druge strane, nekorišćenje ili nepravilno korišćenje dečjih bezbednosnih sedišta u direktnoj je vezi sa stradanjem i težinom povreda dece u slučaju saobraćajne nezgode.

Pored opšteg doprinosa sistema zaštite bezbednosti dece u vozilu, potrebno je dodatno poštovati i standarde u sistemima zaštite koji su povezani sa decom određenog uzrasta, jer korišćenje neodgovarajućeg sistema zaštite može povećati rizike i dodatno doprineti negativnim efektima saobraćajne nezgode. Zbog toga, istraživači rizike posmatraju različito u odnosu na uzrast deteta, a za nekorišćenje sistema zaštite kod dece putnika najveća odgovornost se pripisuje roditeljima.

Analizira veze (korelaciju) između korišćenja bezbednosnih sedišta za decu i posledica saobraćajnih nezgoda u kojima stradaju deca u svojstvu putnika, rezultati istraživanja potvrdili su da se sa smanjenjem nivoa korišćenja sistema zaštite (dečjih bezbednosnih sedišta) povaćava broj poginule i teško povređene dece putnika u saobraćajnim nezgodama i obrnuto.

Kod navedene negativne vrednosti (koeficijenta) korelacije statističke značajnosti su na visokom nivou, pa se dobijene vrednosti mogu posmatrati sa velikom pouzdanošću.

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THE ROLE AND IMPORTANCE OF CHILD PROTECTION SYSTEMS AS PASSENGERS IN THE VEHICLE, ANALYSIS OF THE SAFETY OF CHILDREN IN CHILD SEATS

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Abstract: Safety seats for children are part of the passive safety system inside the vehicle. This text explains the role and importance of safety seats for children in protecting the younger population of child passengers in a vehicle during a traffic accident, i.e. a vehicle collision.

Also, this text presents the results of individual studies on the contribution of child safety seats in the protection of children during collisions, depending on the position in the vehicle and the type of accident.

For safety reasons, it is it is regulated that children under the age of 12 can only be transported in the back seats.

This regulation is prescribed for the purpose of better protection, because the back seats provide the best combination of safety elements for passengers of this age.

Exceptionally, children under the age of three can be transported in the front seat, under certain, strictly prescribed conditions.

If child protection systems are not used in the car, it is directly related to the severity of the consequences in the event of a traffic accident.

Many studies show that the correct use of safety seats for children significantly reduces the risk of serious injury and death of children in a collision or overturning of the vehicle.
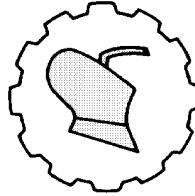
ENGINEERING PROPERTIES OF *Dioclea Reflexa* (*Hook F.*) SEED RELEVANT TO MACHINE PROCESSING AND BULK HANDLING

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Abstract: Interest is growing in the utilization of fringe plant materials such as *Dioclea reflexa* seed to cater for the need of growing global population. It has demonstrated potentials for a wider use as human food, and as industrial raw material. This research focused on determines the engineering properties of the seed that will be useful in the design or selection of industrial machinery for its processing and bulk handling. Four types of tests were carried out on the seeds: geometric, gravimetric, frictional and mechanical tests. Results revealed that the seed's mean geometric diameter was 25.84mm at 5.60 % (w.b.) moisture content. The individual seed average mass, true density and bulk density were 7.76g, 948.5kg·m^{-3} and 558.5kg·/m^3 respectively. Among the surfaces tested, glass has the lowest coefficient of friction (0.221) while wood has the highest (0.424). Seed orientation during compression test has effect on fracture force, deformation, toughness as well as energy absorbed. Variation of mechanical properties along axes of orientation in quasi-static compression of the seeds showed that major axis has the highest mean fracture force, mean deformation to fracture, and mean fracture energy at 1.38kN, 3.05mm and 2.10J respectively. However, the axis with the highest strength is the minor axis at 1.01kNmm^{-1}. From energy efficiency point of view, when designing machine for cracking the seeds, provision must be made for the seeds to be oriented in such a way that the applied cracking force will impact the seeds along their major axis.

Key words: *Marble Vine, Dioclea reflexa, seed physical properties, seed mechanical properties, uni-axial compression test*

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INTRODUCTION

The ever-increasing global population is making governments and researchers to continue looking for alternative resources in addition to the traditional ones to meet the material needs of this growing population. In this context, seeds that, hitherto, are on the fringe of human utilization but which can boost food production as well as serve as industrial raw materials are worthy of being studied. One example of such fringe seeds as far as human consumption or use is concerned is the *Dioclea Reflexa* seeds. This seed has several vernacular names, such as Sea purse, Sea beans, Marble vine, Horse eye, Bonkele (Lingala), Ukpo (Igbo, South-East Nigeria) and Agba-arin (Yoruba, South-West Nigeria) [1]. The species *Dioclea reflexa Hook* belong to *Leguminosae* family and placed in *Papilionaceae* sub-family [2]. *Dioclea reflexa* is native to west-central tropical Africa, Caribbean and tropical region of South America. Propagation is by seeds.

Several researchers had carried out research into pharmaceutical properties of the seed. Study had shown that the *Dioclea reflexa* seeds contain alkaloid and glycosides, which are of pharmacological significance and its high levels of carbohydrates, crude protein and moisture content, could serve as supplementary sources of essential nutrient to man and livestock [3]. *Dioclea reflexa* holds the potential to be used in development of functional foods and in therapeutic applications to promote health [1]. Research also shows that *Dioclea reflexa* seeds contain substances with potent capacity to protect the kidney and blood from oxidative and related injuries under acute and chronic toxicological conditions [4]. Moreover, the seed flour was reported to have anti diabetic properties [5] as well as strong antioxidant properties [6]. It has been recommended that adequate intake of antioxidant through the consumption of anti- oxidant rich foods can prevent the development of oxidative stress.

Reported, [7] that *Dioclea reflexa* oil could act as a good domestic and industrial substitute for conventional oils, while its oil seed cake could be a source of protein in livestock production. Research by [8] confirmed the functional, pasting, nutritional and sensory qualities of wheat based biscuit supplemented with *Dioclea reflexa* seed flour. Still on possible industrial applications, the high saponification and iodine values of *Dioclea reflexa* oil suggest its possible utilization in alkyd resin, shoe polish, liquid soap and shampoo production, while it natural gum has a potential as food and pharmaceutical additive [2, 9, 10].

In most research work reviewed about determination of pharmaceutical and or nutritional values of *Dioclea reflexa* seeds, the seeds preparation for laboratory tests usually involved manual cracking of the hard husk while the seeds are milled using laboratory grinders or laboratory mortar and pestle [5,6,9]. This method of preparation is suitable for laboratory research involving relatively small quantities of seeds. Obviously, this method will be highly impractical and inefficient when dealing with large quantities of seeds as raw materials in industrial processing. A good understanding of the physical properties of raw agricultural material is very crucial for accurate design of machines and processes in the food chain from harvest to shop shelf [11].

[12] investigated the influence of moisture content on some physical properties of *Dioclea reflexa* seed as well as effect of both moisture content and seed orientation during uni-axial quasi-static loading using universal tensile machine to determine some of its mechanical properties.

Properties investigated in relation with moisture contents were seed's linear dimensions, geometric mean diameter, sphericity, surface area, rupture force and rupture energy. However, information are lacking on the seed's other engineering properties such as Eccentricity index, Flatness Index, Aspect Ratio, seed true density, bulk density, porosity, coefficient of frictions between the seed and more common engineering material surfaces, strength, and magnitude of seed deformation before onset of rupture. Therefore, this study aim to provide information on these parameters as related to *Dioclea reflexa* seeds. These set of data will provide relevant information about the seed that will be very crucial in designing machinery for its bulk handling and processing.

MATERIAL AND METHODS

Dioclea reflexa seeds used in this study was sourced from the local seed market located at Oja-Oba (Lat. 7.766º N, Long. 4.555º E) in Osogbo, Nigeria. On arrival at the laboratory, 100 mature seeds were randomly selected from the purchased pile. While the rest were preserved in jute sack placed in a well ventilated space. Some samples of the seeds were sent for identification at the Department of Plant Science, Osun State University Osogbo, Nigeria, the result of which was positive. Four types of tests as related to engineering properties were carried out on the seeds: geometric, gravimetric, frictional and mechanical tests.

Determination of the geometrical properties

For the geometrical and morphological properties, three linear dimensions were identified for the seed: the major diameter or length (L), intermediate diameter or width (W) and minor diameter or thickness (T) as depicted in Figure 1. The linear dimensions of each of the selected 100 seeds were measured using a digital electronic Vernier caliper (Mitutoyo, Japan) with an accuracy of ±0.02mm. The arithmetic mean diameter, geometric mean diameter, seed volume, and seed surface area were determined using Equations (1) to (4) [13-14].
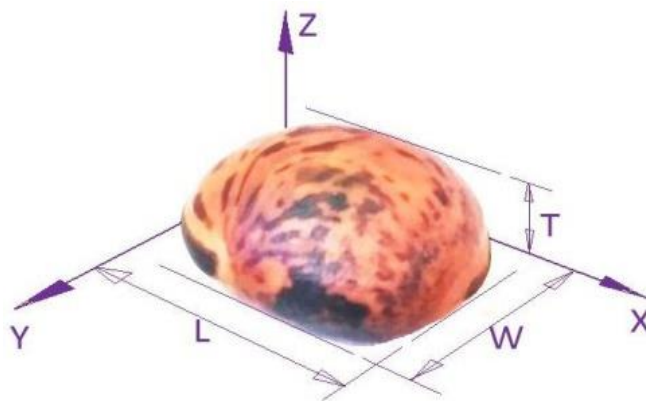
Figure 1. Three perpendicular dimensions of *Dioclea reflexa* seeds;
length (L), width (W) and thickness (T).

$$D_a = \frac{L+W+T}{3} \qquad \text{………………...…... (1)}$$
$$D_g = (LWT)^{1/3} \qquad \text{………………….………(2)}$$
$$V = \frac{\pi\,(LWT)}{6} \qquad \text{……………………….(3)}$$
$$A_s = \pi\,(D_g)^2 \qquad \text{……..…………(4)}$$

Where D_a is the arithmetic mean diameter (mm), D_g is the geometric mean diameter (mm); V is the seed volume (mm^3), and A_s is the surface area (mm^2). To further detail the geometric properties of the seeds, sphericity which is the degree of roundness of the seeds, Eccentricity index, Flatness Index, and Aspect Ratio were determined using Equations (5) to (8) below [13,15, 16]:

$$\Phi = \frac{D_g}{L} \qquad (5)$$
$$EI = \frac{L}{W} \qquad (6)$$
$$FI = \frac{L+W}{2T} \qquad (7)$$
$$AR = \frac{L}{T} \qquad (8)$$

Where:
Φ is the degree of Sphericity,
EI is the Eccentricity index,
FI is the Flatness Index,
AR is Aspect Ratio.

Determination of the Gravimetric properties

The moisture content of the *Dioclea reflexa* seeds used in this study was determined by the oven drying method specified in the Association of Officiating Agricultural Chemists [17] The samples' moisture content on a wet basis (w.b.) was calculated using Equation (9). The moisture content (*MC*), was defined based on a wet basis as:

$$MC_{WB}\,(\%) = \frac{M_W - M_D}{M_W}\,X\,100 \qquad (9)$$

Where,
MC_{wb} is the moisture content on a wet basis of the *Dioclea reflexa* seeds (% w.b.),
M_W is the initial weight of the *Dioclea reflexa* seeds (g),
M_D is the weight of the *Dioclea reflexa* seeds after drying (g).

Seed weight was determined for 15 randomly selected seeds from the original 100 seeds and each seed weigh individually on electronic weighing balance (Ohaus Corp, Pine Brook, NJ, USA) with readability of 0.0001 g. The true density (ρ_t) was determined as the ratio between the mass of the *Dioclea reflexa* seeds samples and the true volume of the samples using the expression in Equation (10) as:

$$\rho_t = \frac{M_s}{V_s} \qquad \text{……………..(10)}$$

Where,

Ms is the mass of the seeds sample (kg) ,

Vs is the volume (m³) of the sample determined using the displacement method.

This procedure was repeated for five different sets of seeds samples. The bulk density (ρ_b) was determined by first weighing a cylindrical vessel of known volume. Then the container was filled with the seeds until their level just reached the level of the container rim. The mass of the vessel and the seeds were then weighed and the bulk density calculated [13], using Equation (11):

$$\rho_b = \frac{M_{sv} - M_v}{V_v} \qquad\qquad ....(11)$$

where M_{SV} is the mass of seeds and container (kg), M_V is the mass of the vessel only (kg) and V_V is the volume of the vessel (m³). From the results of Equations (10) and (11), the porosity (ε) was calculated [13] from the values of the bulk and true densities using the relationship in Equation (12) as:

$$\varepsilon = \left(1 - \frac{\rho_b}{\rho_t}\right) \times 100 \qquad\qquad ....(12)$$

Where, ρ_b is the bulk density (kg·m⁻³),

ρ_t is the true density (kg·m⁻³).

Determination of static coefficients of friction

Coefficient of static friction between the seeds and some representative surfaces were determined experimentally by using the tilted plate method described by many researchers [18]. A hollow cardboard cylinder opened at either ends filled with the seeds was placed on the surface of a plate made from the material of interest and the cardboard cylinder was slightly raised to ensure that only the seeds has contact with the plate surface. After this, the plate was gradually raised at one end and rotates about a hinge at the other end. The angle of inclination with the horizontal at which the sample initiated its sliding was read off a protractor with a sensitivity of one degree. The tangent of the angle in which sliding was initiated is the coefficient of static friction [18-19]. This procedure was repeated five times for each material surfaces tested. Five material surfaces, namely wood, galvanized steel sheet, mild steel sheet, aluminum sheet, and glass were tested.

Determination of the mechanical properties

Using the American Society of Agricultural and Biological Engineers -ASAE S368.4 [20] standard as a guide in determining the mechanical properties of the *Dioclea reflexa* seeds, uni-axial compression tests were carried out on the seeds using the Universal Testing Machine (Haida International, China) controlled by a micro-computer (Figure 2).

The S368.4 standard was developed especially for determining the mechanical properties of food material of convex shape such as fruits and vegetables, seeds, and grains.

The force-deformation curve, which is an output of the test, was frequently used in the study of physical properties of seeds and grain [11]. There are four basic values that can be obtained from this uni-axial compression test: force (maximum load), deformation (displacement), slope (ratio of force to deformation i.e. stiffness modulus), and area under the force/ deformation curve (energy absorbed, i.e. Toughness). The loading rate was $0.1 kN \cdot sec^{-1}$. The placement of the seeds on the plate of the machine was based on orientation along the three axis identified for the seed, that is; along the axis of the major, intermediate and minor diameters respectively as shown in Figure 3.

Figure 2. Placement of seed between the platens of Haida International- Mechanical Universal Testing Machine used in compression tests.

Ten seeds were tested for each orientation. The compression test was run for each seed until rupture occurred. The onset of seed rupture was announced by a popping sound. As the compression commenced and progressed, the computer in response to the compression of each seed automatically plotted a load deformation curve.

From the Load-deformation curve, fracture force (F) in kN and deformation (d) in mm to rupture was determined. The slope of the Load- deformation curve gives the stiffness value for the seed in $kN \cdot mm^{-1}$. The energy absorbed (Toughness, E_T) by the seed sample at rupture was determined by calculating the area under the force-deformation curve up to the rupture point from the following Equation (13):

$$E_{T} = \frac{Fd}{2} \qquad \qquad \qquad \text{................. (13)}$$

Where, F is the fracture force (kN),
        d is the deformation (mm)
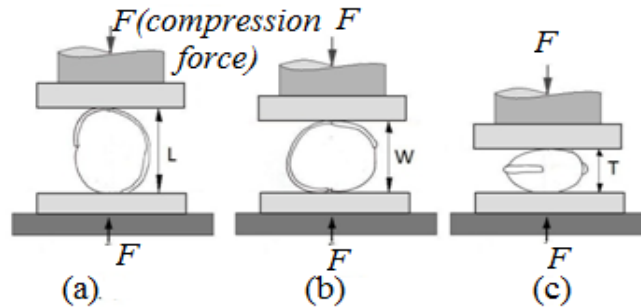
Figure 3. Orientations of the seeds on the universal testing machine (a) along major diameter, (b) along intermediate diameter, (c) along minor diameter.

Statistical analysis

The data obtained from the tests, measurements and experiments as detailed in the previous sub-sections were subjected to descriptive statistical analysis. Range (maximum "Max" and minimum "Min"), average, and standard deviation (SD), were calculated by using Microsoft Excel (2007) spreadsheet. In addition, t-test was used to determine if there is significant difference between the mean values obtained for mechanical properties.

RESULTS AND DISCUSSION

The initial moisture content of the *Dioclea Reflexa* seeds was found to be 5.60 % (wet basis). This value is within the normal values for the seed in post-harvest storage [12]. The results for geometric, gravimetric, frictional and mechanical tests carried out on the seeds are as presented in the subsequent sub-sections.

Geometrical properties

The geometric properties of *Dioclea Reflexa* seed is shown in Table 1. The average length, width and thickness were 30.91, 26.91 and 20.81mm respectively with mean geometric diameter of 25.84mm. The average sphericity, eccentricity and flatness indices as well as aspect ratio were 83.7%, 1.15, 1.39 and 1.49 respectively. The mean volume and surface areas respectively were 9136.58mm^3 and 2101.37mm^2. The values of the linear dimensions will be useful in the design of sorting machine especially those employing perforated holes to do the sorting. The sphericity value implies that *Dioclea Reflexa* seed has a very high degree of roundness when compared with a sphere.

These indicate that the seed has propensity to roll rather than slide on the processing surfaces and this property is important in the design of hoppers and belts for handling and conveying operations respectively.

The surface area value is an important parameter in designing dryers for the seeds if needed in further processing. The seed's volume can be used to determine the number of seeds a specific space can accommodate, especially for seed packaging.

Generally, the physical properties such as size, volume, density, porosity and surface area of agricultural materials are critical data in design problems associated with development of machines for processing or analysis of such materials [13]. Compared with more common edible seeds, the length, width, thickness and sphericity for pecan (*Carya illinoinensis*) is 54.3, 25.1, 23.2mm and 58.38% respectively at 10.36 % (d.b.) moisture content [21]; for Hazel nut (*Corylus avellana*) (Kargalak cultivar) 25.08, 21.20, 21.20mm and 89.51% respectively [22]; and for pistachio nut (*Pistacia vera*), 19.6, 10.1, 11.3mm, and 82% respectively at 7.1 % (w. b.) moisture content [23]. For *Mucuna Sloanei*, a related seed, the major diameter, minor diameter, intermediate diameter and the sphericity, ranged from 25.61 to 32.52 (mm); 17.84 to 20.66 (mm); 24.24 to 30.18 (mm); and 0.82 to 0.89 respectively (moisture content 10.5 to 16.87% (db) across its two varieties studied by [24].

Table 1. Geometric properties of *Dioclea reflexa* seed*

	Min.	Max.	Average	SD
Major Diameter, L [mm]	25.0	35.3	30.909	1.6900
Intermediate Diameter, W [mm]	23.0	30.2	26.912	1.582
Minor Diameter, T [mm]	18.4	24.0	20.807	1.1974
Arithmetic mean diameter [mm]	23.57	28.40	26.209	1.1111
Geometric Mean Diameter [mm]	23.3	28.08	25.843	1.0799
Volume (mm^3)	6701.01	11357.91	9136.58	1149.53
Surface area (mm^2)	1705.76	2477.42	2101.37	175.66
Sphericity (%)	75.0	94.0	83.7	2.98
Eccentricity index	1.00	1.35	1.1498	0.0634
Flatness index	1.15	1.63	1.3934	0.0938
Aspect ratio	1.19	1.84	1.4873	0.1121

*For 100 randomly selected mature seeds, SD= Standard Deviation

Gravimetric properties

The gravimetric properties of the seeds are as presented in Table 2. The individual seed average mass was 7.76g, the true density was 948.5 kg·m^{-3} and bulk density was 558.5kgm^{-3}. The density ratio and porosity was calculated as 1.72 and 41.86% respectively. These values are very useful in designing conveyance for the seeds during industrial processes. It also has impact on power rating of processing machines since the more bulky, the more power requires in moving the seeds around in processing.

For comparison, the individual seed average mass for pecan nut (*Carya illinoinensis*) was 9.76g at 10.36 % (d.b.) moisture content [21] and for Hazel nut (*Corylus avellana*) (Kargalak cultivar) was 4.15g [22].

Table 2. Gravimetric properties of *Dioclea reflexa* seed

	Min.	Max.	Average	SD
Individual Seed Mass (g)*	6.5803	10.1859	7.7582	0.8223
Seed (True) Density (kg·m^{-3})†	914.95	970.20	948.50	29.48
Bulk Density (kg·m^{-3}) †	516	615	551.5	43.96

for 15 randomly selected seeds, †for 5trials, SD= Standard Deviation

Coefficients of friction

The coefficients of friction between *Dioclea Reflexa* seeds and some representative surfaces commonly found in food processing machines and storage compartments are as depicted in Table 3. The glass surface (Coefficient of friction 0.221) presented the lowest coefficient of friction while wood (0.424) has the highest. For comparison, coefficient of friction between Mexican pink pinion (*Pinus pinea L.*) and glass was 0.45 and plywood 0.35 at 7.58% moisture content [25]. Coefficient of friction is an indication of how easy it is for the seeds to slide on an inclined surface as well as determining whether a seed will roll instead of sliding. If the coefficient of friction is relatively high, rolling might be a preferred form of motion for the seeds when being fed to a chute.

Table 3: Coefficients of friction of *Dioclea reflexa* seed on selected surfaces

	Aluminum	Glass	Wood	Galvanized Steel	Mild Steel
Mean	0.250	0.221	0.424	0.251	0.360
S.D.	0.0431	0.0245	0.0381	0.0497	0.0083

SD= Standard Deviation

Mechanical properties

The mechanical properties of *Dioclea Reflexa* seeds are as presented in Table 4 and the typical load-deformation curves for each seed orientation was as shown in Figure 4. Of the three possible orientations of the seed in compression testing, fracture force is consistently higher for major axis orientation (i.e. along length) while it is lowest for minor axis orientation (i.e. along thickness). There is significant difference at 0.05% between fracture force along the major axis and of the other two axes. However, though that of intermediate axis was slightly higher than that of the minor axis, there is no significant difference (at 0.05%) between the two.

In deformation, similar trend was observed with deformation highest (average 3.05mm) along major axis and lowest (0.95mm) along the minor axis. There is significant difference between the three axes in term of deformation at 0.05%.

Table 4. Mechanical properties of *Dioclea reflexa* seed

	Orientation								
	Major Axis			Intermediate Axis			Minor Axis		
	Min	Max	Mean (SD)	Min	Max	Mean (SD)	Min	Max	Mean (SD)
Fracture force (kN)	1.10	1.60	1.38 (0.19)	0.55	1.45	0.98 (0.27)	0.55	1.40	0.94 (0.26)
Deformation to fracture (mm)	2.40	4.00	3.05 (0.45)	0.70	3.50	1.47 (0.79)	0.70	1.40	0.95 (0.25)
Strength (kN·mm^{-1})	0.29	0.63	0.46 (0.09)	0.29	1.07	0.77 (0.24)	0.61	1.57	1.01 (0.25)
Energy absorbed (J)	1.50	2.71	2.1 (0.41)	0.19	1.75	0.75 (0.46)	0.25	0.98	0.47 (0.25)

SD= Standard Deviation
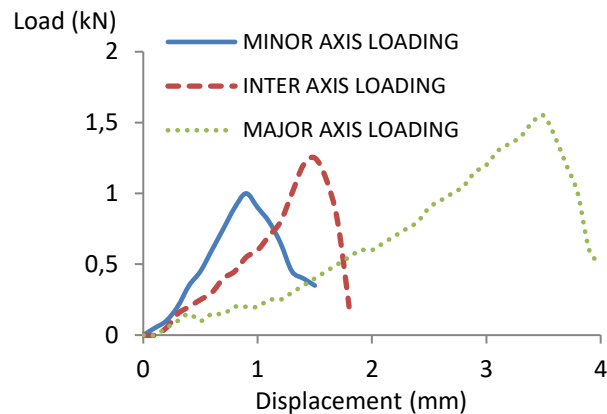
Figure 4. Typical Load-deformation curves for *Dioclea reflexa* seed under uni-axial compression test.

The seeds have greatest strength along the minor axis. This is because though fracture force is lowest along this particular axis, its deformation is also the least among the three axes. The converse is also true for major axis which has the greatest fracture force and deformation. This implies that there is greater resistance to deformation along minor axis when compared with the other two.

For comparison, *Mucuna flagellipes* nut, a biological relative of *Dioclea Reflexa* seed, at 3.38% moisture content (dry basis) exhibits a rupture forces of 685N and 420N respectively for lateral and longitudinal loading of the seeds and at 10.7% moisture content (d.b.) rupture forces of 365N and 1215N respectively for lateral and longitudinal loading of the seeds.

These shows that moisture level as well as seed orientation during compression tests has influence on rupture forces for the *Mucuna flagellipes* nut with the force decreasing for lateral orientation and increasing for longitudinal orientation as moisture content increases [26].

Moreover, for acorn nuts, [27] reported the rupture force values of 367.84, 480.53, and 401.19N for loading on lateral, vertical and thickness axes respectively at a moisture content of 5.48% (d.b.). Thus orientating has an obvious effect on the value of rupture force.

CONCLUSION

The high sphericity value of *Dioclea Reflexa* seed indicate that the seed has propensity to roll rather than slide on the processing surfaces of processing machines, however the bulk density and porosity are well within the range of common well established food grade seeds. Seed orientation during compression test was shown to have effect on fracture force, deformation, toughness as well as energy absorbed. This is similar to trends observed for similar agricultural materials. Fracture force, deformation to fracture and fracture energy were highest for loading along the major axis with the minor axis having the lowest corresponding values. However, in term of seed strength under compressive load, the minor axis has the highest value while the major axis has the lowest value. From energy efficiency point of view, when designing machine for cracking the seeds, provision must be made for the seeds to be oriented in such a way that the applied cracking force will impact the seeds along their minor axes.

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INŽINJERSKE OSOBINE SEMENA *Dioclea Reflexa* (*Hook. F.*) RELEVANTNE ZA UPOTREBU MAŠINE KOD ZAPREMINSKE PRERADE

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Apstrakt: Raste interesovanje za korišćenje sporednog biljnog materijala kao što je seme *Dioclea reflexa* da bi se zadovoljile potrebe rastuće globalne populacije. *Dioclea reflexa* ima potencijale za širu upotrebu kao ljudska hrana i kao industrijska sirovina.

Ovo istraživanje fokusirano na utvrđivanje inženjerskih osobina semena koje će biti od koristi u projektovanju ili izboru industrijskih mašina za njegovu preradu i rukovanje velikim količinama semena u toku prerade.

Na semenu *Dioclea reflexa* su sprovedena četiri tipa ispitivanja: geometrijska, gravimetrijska (zapreminska), frikciona i mehanička.

Rezultati pokazuju da je srednji geometrijski prečnik semena bio 25,84 mm pri 5,60 % sadržaja vlage. Prosečna masa pojedinačnog semena, prava gustina (zapremina) i nasipna gustina imaju vrednost 7,76g, 948,5 kgm^{-3} i 558,5 kg/m^3 respektivno.

Kod ispitivanja uticaja površina na trenje, staklo ima najmanji koeficijent trenja (0,221), dok drvo ima najveću vrednost (0,424).

Orijentacija semena tokom testa kompresije utiče na silu loma, deformaciju, žilavost kao i na apsorbovanu energiju. Varijacije mehaničkih osobina u pravcu ose orijentacije u kvazistatičkoj kompresiji semena su pokazale da glavna osa (x) ima najveću srednju silu loma, srednju deformaciju kao i lom i srednju energiju loma pri 1,38 kN, 3,05 mm i 2,10 J respektivno.

Međutim, osa orjentacije zrna sa najvećom čvrstoćom je osa (y) sa vrednosti 1,01 kNmm^{-1}.

Sa stanovišta energetske efikasnosti, prilikom projektovanja mašine za deformaciju (lom), mora se predvideti da seme bude orijentisano na takav način da primenjena sila deformacije utiče na seme duž njegove glavne ose.
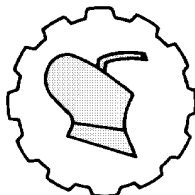
ESTABLISHMENT OF CONTROLLING MECHANISMS IN ORGANIZATION AND MANAGEMENT PROCESSES BY TOP MANAGEMENT IN AGRICULTURAL ENTERPRISES IN THE REPUBLIC OF SERBIA

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Summary: The establishment of controlling as a mechanism that will contribute to economic support in business decision-making processes and the organization of the management structure established by the top management in agricultural enterprises in the Republic of Serbia is extremely important. The essential improvement of business decisions in agricultural enterprises can be linked to the established controlling mechanisms, which was the focus of the authors of this study. In the study, a correlation analysis was performed, which points to the existence of significance at the level of $p<0.05$, between the size of the organization of the agricultural enterprise and the implementation of controlling. In addition, the authors strengthened the research from the aspect of realistic presentation of the analysis of the obtained business results of the observed large and medium-sized enterprises in relation to the introduced controlling mechanism. It was discovered that there is a different success in the obtained business results of agricultural companies that introduced controlling compared to those that did not introduce controlling in regular operations.

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The value of the obtained Pearson Chi-Square is 11.190a, as well as the fact that $p<0.005$, which means that we discovered that the introduced form of controlling significantly affects the operations of medium and large agricultural enterprises in the Republic of Serbia.

Keywords: *controlling, management, income generation.*

INTRODUCTION

The introduction of controlling in the company's operations should be seen as a continuous process aimed at achieving better business success of the company itself. Top management tries to satisfy its set business goals through the introduced controlling, i.e. those it wants to achieve in the management processes of the companies themselves [1-5].

Controlling should be seen as a process that helps the company's top management to achieve the set or set goals. Controlling as a process can be explained by observing the goals, plans and procedures of control itself, which is carried out in companies.

The basic setting of the problem that is imposed on the top management is the setting and definition of business goals. These are general goals that are imposed in the conditions of existence of control and management in companies [6-9].

The goals that are set before management are usually financial, that is, the achievement of business results that are viewed from a financial point of view [10-12]. In addition to the business goals observed in this way, there may also be non-financial goals set by the top management: markets, processes, people, but also the production organization as a whole [13-15].

The manager of a manufacturing company in particular, and therefore also of an agricultural company, defines goals and priorities in the process of developing business plans. In such conditions, the top management makes a plan on how to achieve the set goal of the company's operations. In the mentioned conditions, it is necessary to introduce a control system, the highest level of which is certainly controlling, which includes control of operations, systems, workers, processes in the company with the aim of achieving the most favorable business results of the company's operations.

In addition, the establishment of a control system in agricultural enterprises should be seen as a system for improving management decision-making by top management, and in order to achieve this, it is necessary to establish business control that is based on real documents, which is of particular importance for the organization of business in agricultural enterprises [16-17].

Controlling is the process of observing how the set goals of top management are achieved. Therefore, controlling is a process that continuously takes place within the observed flow, which is described in three steps (goals, plans and control).

METHODOLOGICAL BASIS FOR THE IMPLEMENTATION OF CONTROLLING IN THE REGULAR BUSINESS OF COMPANIES FROM THE FIELD OF AGRICULTURE IN THE REPUBLIC OF SERBIA

For the purposes of this study, the authors observed two forms of agricultural enterprises in order to discover the basic legalities in the issue of impotence and the establishment of controlling. The research was conducted in 110 large and 198 medium-sized agricultural enterprises in the Republic of Serbia.

Namely, a survey was conducted during January 2023 in the mentioned 308 companies with the aim of top management filling in data on whether they have introduced controlling as a system for establishing control in regular business or not.

The next field of research was to observe the operations of the surveyed 308 companies from the field of agriculture in relation to the achieved results of operations in relation to established controlling as a form of control in agricultural enterprises.

THE BASIS FOR THE ESTABLISHMENT OF CONTROLLING IN LARGE AND MEDIUM-SIZED AGRICULTURAL ENTERPRISES IN THE REPUBLIC OF SERBIA

The presentation of the basis that enables the establishment of one of the most important forms of control in the entire operation of an agricultural enterprise depends on the establishment of controlling.

The observation was carried out in relation to two ordinary enterprises, namely large and medium-sized agricultural enterprises in Republic of Serbia.

The authors systematized the presentation of the research results in Table 1.

Table 1. Presentation of the application of controlling in large and medium-sized enterprises in Republic of Serbia

The form of organization of an agricultural enterprise	An agricultural company that introduced controlling into regular operations	The agricultural enterprise has not established controlling in its operations	Total
	No.	No.	No.
Big companies	82	40	122
Medium Enterprises	28	158	186
Total	110	198	308

Source: Authors' calculations

CORRELATION ANALYSIS OF THE RELATIONSHIP OF THE SIZE OF THE AGRICULTURAL ENTERPRISE AND THE INTRODUCED CONTROLLING IN REGULAR BUSINESS BY THE TOP MANAGEMENT

The authors observed the size of the agricultural company and the introduced controlling in the regular operations of top management of the aforementioned companies with the aim of discovering the existence of a statistically significant relationship between the size of the organization and the implementation of controlling in their actual operations.

Correlation was calculated based on the Phi coefficient for dichotomous variables. The test results are shown in Table 2.

Table 2. Presentation of the correlation coefficient and application of controlling
in large and medium-sized agricultural enterprises

Description	Variables	Value	Approx. Sig.
Nominal by Nominal	Phi	.159	.008
	Cramer's V	.159	.008
N of Valid Cases		308	

Source: Authors' calculations

CHI-SQUARE TESTS AS A REAL ANALYSIS OF THE BUSINESS RESULTS OF OBSERVED LARGE AND MEDIUM-SIZED COMPANIES IN RELATION TO THE INTRODUCED CONTROLLING MECHANISM

The authors performed Square tests with the aim of presenting a realistic analysis of the results that speak about the operations of the observed large and medium-sized companies in relation to the introduced controlling mechanism through the analysis of the realized results of the operations of the mentioned companies.

The obtained research results are presented in table 3.

Table 3. Presentation of Chi-Square Tests of the achieved results of agricultural enterprises
and introduced controlling

Used for testing	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.190[a]	2	.004
Likelihood Ratio	10.486	2	.005
Linear-by-Linear Association	6.838	1	.009
N of Valid Cases	308		

Source: Authors' calculations

DISCUSSION

After displaying the obtained results in Table 2 and based on the obtained results of the correlation coefficient Phi=0.16, it can be seen that there is significance at the level of $p<0.05$. Essentially, it can be observed that there is a statistically significant relationship between the size of the agricultural enterprise organization and the implementation of controlling. Essential observation was made between two forms of introduced and non-introduced controlling in the regular operations of large and medium-sized agricultural enterprises.

Based on the obtained results in Table 3, it can be seen that the value of Pearson Chi-Square is 11.190a, as well as that the value is $p<0.005$, which means that the introduced form of controlling influenced the different operations of medium and large agricultural enterprises. Essentially, it can be said that controlling affects at least one of the forms of companies that differ in size, that is, within the analyzed groups.

There is a significant difference in the application of controlling mechanisms in agricultural enterprises, which are different in size. In large companies, controlling is most often applied around 75%, while medium-sized agricultural companies apply controlling with approximately 25%, which can be seen in the presentation of the obtained results in table 3, regardless of the uneven number of surveyed samples.

CONCLUSION

The author's research shows that there is great importance in the application of controlling. The introduced controlling can essentially direct the business of an agricultural company in the right direction, that is, it can ensure better business in the future for companies whose top management decided to introduce controlling. The first conclusion reached by the authors of the paper is that the size of the agricultural enterprise affects the implementation of controlling. Another conclusion would be that there is a significant difference in the application of controlling mechanisms in relation to the size of agricultural enterprises. We discovered that controlling is most often applied to large companies and that is about 75%, while medium-sized agricultural companies apply controlling with approximately 25%, which affects the overall operations of the observed companies. Also, as a final conclusion, it can be said that agricultural companies that have introduced controlling in their regular operations achieve better business results.

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USPOSTAVLJANJE MEHANIZMA KONTROLINGA U PROCESIMA ORGANIZACIJE I UPRAVLJANJA OD STRANE TOP MENADŽMENTA U POLJOPRIVREDNIM PREDUZEĆIMA U REPUBLICI SRBIJI

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Sažetak: Uspostavljanje kontrolinga kao mehanizma koji će doprinositi ekonomskoj pratnji u procesima poslovnog odlučivanja i organizaciji upravljavljačke strukture koju uspostavlja top menadžment u poljoprivrednim preduzećima u Republici Srbiji je od izuzetne važnosti. Suštinsko unapređenje poslovnih odluka u poljoprivrednim preduzećima može se dovesti u vezu sa uspostavljenim mehanizmima kontrolinga, što je bilo u fokusu autora ove studije.

U studiji je urađena korelaciona analiza koja upućuje na postojanje značajnosti na nivou $p < 0.05$, između veličine organizacije poljoprivrednog preduzeća i implementacije kontrolinga. Osim toga, autori su uradili osnaženje istraživanja sa aspekta realnog prikaza analize dobijenih rezultata poslovanja posmatranih velikih i srednjih poljoprivrednih preduzeća u odnosu na uvedeni mehanizam kontrolinga.

Otkriveno je da postoji različita uspešnost u dobijenim rezultatima poslovanja kod poljoprivrednih preduzeća koja su uvela kontroling u odnosu na ona koja nisu uvela kontroling u procese redovnog poslovanja.

Vrednost dobijenog Pearson Chi-Square iznosi 11.190[a], kao i to da je vrednost p<0,005, što znači da smo potvrdili da uveden oblik kontrolinga bitno utiče na poslovanje srednjih i velikih poljoprivrednih preduzeća u Republici Srbiji.

Ključne reči*: kontroling, upravljanje, ostvarenje prihoda.*