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INVESTIGATION OF THE ADHESIVE PROPERTIES OF ZEA MAYS

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Abstract

In this study, the wet extraction method was used in the extraction of starch from seed and cobs of Zea mays. Different formulations were performed to obtain the optimum quality. Zea mays was found to have an average density of 7.5 g/cm^3 and a viscosity of 3.16 x 10^6 cp. The density of the fixative was found to compare favorably with the commercial one.

Keywords*: Zea mays, adhesive, fixative, starch.*

Introduction

Zea mays is one of the oldest human cultivated crops. It has gained many agronomical significant attributes but it has lost the ability to survive in the wild (Prasetiyo et al., 2018). Zea mays, commonly referred to as corn, has been extensively domesticated, resulting in significant alterations to its reproductive characteristics. One major consequence of this domestication is that corn seeds have reduced dormancy, particularly in northern growing regions. This decreased dormancy means the seeds are less likely to remain viable in the soil for long periods without germinating (Krishnaswamy et al., 2023)

Zea mays cannot reproduce effectively in the wild outside of cultivated settings. It lacks the necessary traits to thrive and spread in natural environments, making it a non-invasive species. Consequently, corn depends entirely on human agricultural practices for its reproduction and survival, underscoring the substantial influence of domestication on its biology and ecology. This reliance on cultivation demonstrates how domesticated plants can become highly specialized for human use, often losing their ability to adapt to natural ecosystems (Huang & Dooner, 2008)

Most of the common fixatives currently in use in Nigeria are imported and thus the need for fixatives that are locally produced is the main purpose for embarking on this study (Akgul et al., 2010). Similarly, increasing interest has been cast upon the research of fixatives from starch because of the environmental pressure of using lesser amounts of synthetic fixatives from biogradeble. Besides environmental pressure, exhausting petroleum resources also drive the researchers to look for alternative resources for local fixatives.

Starch is a white, tasteless and odourless powder that is insoluble in cold water or alcohol. It can be used in processed foods or in paper industry. Some starch products manufactured from natural resources, such as maize, cassava or potatoes can offer the polymer industries inexhaustible and green resources (Imolowame et al,, 2016). With necessary modification and processing, Zea mays can be used as an ideal starch fixative that comes from nature and readily goes to nature.

The secondary product (Zea mays starch) from the product, such as akamu (one of the most important food item from Zea mays) is generally not used. These products are drained off most times without any intention for investigating their potentials (Imade&Babalola., 2021). It is in the light of this and the availability of Zea mays that this research was carried out to study the potential of Zea mays as a fixative. The most popular is the stability of the product over a period, thus a relatively short pot-life. This study seeks to obtain conditions that could enable the stability of fixatives from starch of Zea mays.

Materials and Methods

The seeds and cob of Zea mays were obtained and used for the production of the adhesives/fixatives. The parts were washed, crushed, ground and milled. The paste obtained was put in a fine filter bag and squeezed. The filtrate was collected and allowed to sediment. Decanting separated the starch-water mixture. The resultant seepage was weighed and dried under ambient temperature to a constant weight.

An amount of 5.0 g of the extract from the Zea mays seeds in 50 cm^3 of 0.01 M HCl (aq) was heated of a hot plate to a temperature of 100^0C with stirring. The mixture was allowed to cool to a lower temperature and consequently stabilized. The procedure was also repeated with samples from the cobs. A portion of the fixative from Zea mays seed was taken in a container and at a temperature of 80^0C sodium tetraborate was added. The addition of was continued until the product became sticky. This was repeated at various temperatures to determine the most suitable stabilization temperature and optimum suitable tetraborate requirement. The viscosity of the product was determined using the standard method of viscosity determination. The procedure was repeated using the sample from the cobs.

Results and Discussion

The results of the production experiment are presented in tables 1 to 5. A commercial synthetic fixative, trade marked Multisite was analyzed for basis of comparison. The fixative was found to have a density of 1.01 g/cm^3 and viscosity of 3.91 x 10^6 cp. The density of the developed starch

fixative was found to compare favorably with the commercial one. However, the viscosity varied with the amount of borax added as can seen in Tables 3 and 4.

Table 1. Development of fixatives using Zea mays seeds

Weight of dry extract (g)	Volume of 0.01 M HCl (ml)	Volume of fixative used (ml)	Density of product (g/cm^3)
5.0	20.00	35.70	1.015
5.0	30.00	35.90	1.013
5.0	40.00	35.60	1.012
5.0	50.00	35.80	1.011

Table 2. Development of fixative using Zea mays cobs

Weight of dry extract (g)	Volume of 0.01 M HCl (ml)	Volume of fixative used (ml)	Density of product (g/cm^3)
5.0	20.00	34.00	1.030
5.0	30.00	35.50	1.022
5.0	40.00	35.70	1.021
5.0	50.00	35.80	1.020

Table 3. Stabilization of fixative from Zea mays cobs

Volume of extract (ml)	Quantity of borax (g)	Temperature (^0C)	Viscosity of fixative (x 10^6 cp)
50.00	0.18	80	7.59
50.00	0.15	75	7.20
50.00	0.12	70	6.44
50.00	0.08	65	4.13

Table 4. Stabilization of the fixative from Zea mays seed

Volume of extract (ml)	Quantity of borax (g)	Temperature (0C)	Viscosity of fixatives (x 10^6 cp)
50.00	0.25	80	13.72
50.00	0.22	75	12.28
50.00	0.19	70	8.39
50.00	0.16	65	2.91
50.00	0.13	60	1.13

Table 5 shows the relationship between the borax mass and the starch from seed and cob of Zea mays. Using the viscosity of the commercial fixative as a reference, the optimum temperature and borax requirements for stable fixatives with reduced retro gradation were determine from the data (Masumbu et al, 2003). These conditions were used to produce fixatives which were stabilized and these results are shown in Table 6.

Table 5. Relationship between borax mass and starch sources

Borax mass	Seed starch viscosity ($x10^6$ cp)	Cob starch viscosity ($x10^6$ cp)
0.04	0.80	0.62
0.06	0.85	0.71
0.08	3.84	2.44
0.10	4.76	3.13
0.12	5.26	4.89
0.14	5.30	5.11
0.16	5.33	5.13

Table 6. Relationship between time and viscosity of the fixatives

	Time (days)	0	1	3	5	7	9	11
Viscosity (x 10^6 cp)	Zea mays cob	4.534	4.533	4.533	4.533	4.531	4.530	4.529
	Zea mays seed	4.642	4.642	4.648	4.648	4.643	4.640	4.639

Studies showed that fixatives produced from Zea mays seeds retained a longer stability than that from Zea mays cob. This could be attributed to effect of higher starch content of Zea mays seeds (Torrenegra et al, 2019). The starch also could react with the sodium salf produced from the stabilization.

From the data, the following equations can be deduced for optimum comparative conditions.

For Zea mays seeds:

$T = 187x + 36 \ldots (1)$

$\mu = (49.22 \times 10^7) - 1.1334 \times 10^6 \ldots (2)$

Hence $\mu = 3.08 \times 10^6 T - 1.13 \times 10^6 \ldots (3)$

For Zea mays cob:

$\mu = 6.49 \times 10^6 T - 2.81 \times 10^6 \ldots (4)$

From equations (3) and (4) for a given viscosity the optimum temperature required to get the viscosity could be obtained and hence the borax quantity for the stabilization will be deduced from the data.

Conclusion

Zea mays is readily available and was used to develop non-structural fixatives that are environmentally friendly. Some conditions that could yield optimum production had been specified using the date obtained. The fixative produced from Zea mays seeds and cob are reasonably stable on addition of a chemical stabilizer. The optimum temperature and stabilization material for the production could be obtained from the graphs and the equations developed. Zea mays, or corn, was found to have an average density of 7.5 g/cm³ and a viscosity of 3.16 x 10^6 cp. These values suggest that it has a relatively high density and a notably thick consistency. The density of the fixative used in the study was also similar to that of commercial fixatives on the market, indicating that the fixative's properties are effective and suitable for various applications, potentially making it a feasible alternative for commercial use. These findings underscore the importance of understanding the physical properties of Zea mays, which could impact areas such as agriculture, food science, and material development. Thus, Zea mays starch could be a good source of inexpensive and easily available fixative, thus saving the industries from spending foreign exchange on importation and reducing cost production.

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