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The Effect of Phosphorylation (Sodium Trimetaphosphate) of Faro 40 Rice Starch for the Production of Pharmaceutical Grade Starch

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Nigerian FARO 40 rice starch has been underutilized due to low edible qualities. The aim of this study was to chemically modify underutilized rice variety using standard methods for possible use as pharmaceutical grade starch.
Methodology: The physicochemical properties of native and phosphorylated FARO 40 rice starch were analysed using standard methods. Scan electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), Thermogravimetric analyser and Derivative Thermogravimetric

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analyser were utilized to decide the morphological properties of native and modified starch. The comparative binding and disintegrant capacities of these starch in tablets detailing were examined utilizing paracetamol as model sedate. Paracetamol tablets were defined using wet granulation strategy and direct compression utilizing native starch, acetylated starch, and phosphorylated starch as binders. The tablet features such as smashing quality, friability, crumbling time and disintegration test were assessed utilizing friabilitor machine, deterioration machine and disintegration device.

Results: The results showed significant decreased ($P<0.05$) values in pH, moisture content, and gelatinization temperature for modified starches compared to the native starch. Significant increase observed in ash content, solubility, swelling capacity, browning temperature, charring temperature and amylose content of phosphorylated starch as compared to the native starch. Furthermore, significant changes were also observed in morphology of the phosphorylated starch compared to the native rice starch. The weight, crushing strength, friability, disintegration time and dissolution profile values for paracetamol tablets formulated with the phosphorylated starch were within the standard specified by British pharmacopeia and were significantly different from that of native starch ($P<0.05$).

Conclusion: Chemical modification has shown to improve the physicochemical and morphological properties of the three FARO 40 underutilized Nigerian rice varieties for pharmaceutical purpose.

Keywords: Federal Agriculture Research Oryza (FARO); Sodium Trimetaphosphate (STMP); acetic anhydride; modification; photomicrograph; physicochemical properties.

1. INTRODUCTION

Rice one of foremost important but adaptable nourishment fixings values having included properties for endless industrial uses. Corn, potato, wheat, cassava and rice are the common sources of starch. The most developed cereal crop around the world is rice and integral to billions of people lives around the world [1]. Rice is created broadly for food and industrial uses. Rice serves as staple food for rural and urban ranges in Nigeria and has changed from being subsistent crop to cash crop. Federal Agriculture Research Oryza (FARO) rice may be modern breed obtained at Badegi, Niger State, Nigeria national cereal research institute and cultivated predominately within Bida and its environs of Niger State, Nigeria [2].

Pharmaceutical or food industries utilize starch to either influence or control features like; texture, moisture, consistency and shelf soundness. Starch binds or disintegrates, expands, clarifies, attracts or inhibits moisture. It produce either smooth or pulpy surfaces and soft or crisp coatings [3,4]. Starch serve greatly as multifunctional settling in pharmaceutical industries [5]. Regardless of the sources of native starch, they are undesirable for industrial applications due to failure to withstand situations as uncommon temperature, adverse pH, high shear rate, tall capacity to retrograde, misforture thickness, syneresis affinity and control thickening due to cooking reduced Ph [6,7].

To advance appealing valuable features and overcome its limitations, native starches are often modified. Modification is used to improve basic dejected physicochemical properties of native starch for industrial applications [5]. Chemical form of modification is used for the treatment of native starch with specific chemicals. In this way modified starch are sensible for canning food, surgical cleaning powder and other applications [5,8]. Long time after, significant advances have been achieved in getting non-conventional botanical source starch become valuable in their physicochemical properties [9].

Morphological and physicochemical properties for FARO rice variety has never been study and on these bases, this research aimed at investigating effect of chemical modification on the variety of underutilized Nigerian FARO 15 rice starch for the production of pharmaceutical grade starch.

2. MATERIALS AND METHODS

2.1 Sample Collection

FARO 40 rice used for this work was obtained from the National Cereal Research Institute Badegi, Bida, Niger State, Nigeria.

2.2 Extraction of FARO Rice Starch

The method [10] was used for starch extraction. Put 20 grams of the flour into 200ml beaker and add 0.05M solution of sodium hydroxide and allowed it to stand for 3 hours at room temperature. Drain the steep liquor after three (3) hours and re-dilute with 0.05M sodium hydroxide solution. Continue the process until the supernatant becomes clear and test negative for Biuret test. Centrifuged at 3500 rpm and oven dry at 50˚C overnight. The dried starch sieved with 100 mm sieve and stored until examination at -4˚C in plastic pack.

2.3 Phosphorylation Treatment

Methodology [11] was utilized with slight modifications. About 10 grams of sample was dissolved in 200 ml distilled water, 0.5 g sodium sulphate added and pH adjusted to 9.0 with 1M sodium hydroxide solution. Suspension pre-heated under continuous heating to 70ºC. Three (3g) of modifying agent sodium trimetaphosphate (STMP) was introduced and pH readjusted to 9 with 1M sodium hydroxide. Modification done for 2 hours with constant stirring at room temperature and pH finally reduced to 6 with dilute hydrochloric acid 25% (v/v). The sample was washed with 130 ml ethanol A.P., filtered, and dried at 60ºC for 48 hours.

2.4 Physicochemical Tests

2.4.1 pH determination

Five grams each of native and modified (phosphorylated) starch samples was put into 15ml distilled water and mixed separately. Boiling distilled water was used to make up the slurries to 100ml. Each slurry pH was taken after cooling and recorded. The procedure was triplicated for each sample.

2.4.2 Percentage of moisture loss

The strategy portrayed by [12] was utilized to decide the moisture content of native and phosphorylated FARO rice starches. Five grams of each starch was dried to constant weight at 105^0C. The procedure was triplicated for each sample. Weight reduction recorded.

$$\boldsymbol{Moisture\ Content}\ (\%) = \frac{\mathrm{W1 - W2}}{\mathrm{W1}}\ \mathrm{X}\ 100$$

2.4.3 Ash content determination

The method portrayed by [12] was utilized to decide the ash content of the samples. One and half (1/2) gram of each sample was put into crucible of known weight separately. The crucibles were heated in a furnace for 4hrs at 400^0C, crucibles removed and cooled to room temperature and reweighed. The procedure was triplicated for each sample.

$$\%\ ash\ in\ sample = \frac{Weight\ of\ ash\ in\ sample}{Weight\ of\ sample} X\ 100$$

2.4.4 Acidity level determination

About ten grams of native and modified starch samples were incorporate into 70%v/v alcohol separately using phenolphthalein solution as indicator. Rotary shaker was used to shake the mixtures for an hour; 50ml filtrate from each sample was pipetted and titrated against 0.1M NaOH solution. The method was triplicated for each sample.

2.4.4.1 Solubility

The strategy [13] was used to determine the solubility of each sample. Two grams each of the starch was dissolved in 10 ml cold distilled water separately and drained overnight. About 5ml of the clear supernatant was taken for each and heated to dryness on water bath. The method was triplicated for each sample and the formula below was used to determine the solubility.

$$\boldsymbol{Solubility}\ (\%) = \frac{\text{Dry supernatant weight}}{\text{Initial smple weight}}\ \mathrm{X}\ 100$$

2.4.5 Swelling capacity determination

The procedure [14] was used to determine swelling capacity. About 0.1 g of native and modified sample was weighed into separate test tubes, 10 ml distilled water added to each and the mixtures warmed at 50^0C for 30 min with ceaseless shaking on water bath. On conclusion, each mixture was centrifuged at 1500 rpm for 20 min, supernatant decanted and starch paste weighed. The method was triplicated for each sample and the formula below was used to determine the swelling capacity.

$$\textbf{Swelling capacity} = \frac{\text{Weight of starch paste}}{\text{Weight of drying starch paste}}$$

2.4.6 Gelatinization temperature determination

The method [15] was used. One gram of both native and modified starch sample was put into 20ml beaker separately and 10ml distilled water added to each. Each of the slurry has thermometer inserted into it and heated with hot plate to obtain their gelatinization temperature. The method was triplicated for each sample.

2.4.7 Browning and charring temperature determination

The method [16] was utilized. Few quantity of native and modified FARO 40 rice starch sample was separately put into a capillary tube, using a melting point apparatus title Electrothermal 9100; browning and charring temperature for each sample was determined and recorded. The method was triplicated for each sample.

2.4.8 Viscosity determination

Viscosity was determined utilizing the procedure [17]. The viscosity of each starch mucilages concentration was done with rotational viscometer utilizing shaft 4 at 20 revolutions per minute at room temperature. Starch formulated through the suspension of 10 grams of each starch separately in equal volume of distilled cold water, 250ml distilled boiled water was added to each slurry, mixed properly and mixtures heated to 70^0C on thermostated water bath until translucent mucilage formed. The procedure was triplicated for each sample and their viscosities recorded.

2.4.9 Amylose / amylopectin content determination

Colorimetric method [18] was used. One hundred mg of each sample was transferred into 100 mL volumetric flask separately. 1 ml of 95% ethanol and 9 ml of 0.1N NaOH were added to each mixture separately and the samples were heated for 10 minutes to gelatinize on boiling water bath, cool and make up to volume with distilled water. Pipette 5ml of native and modified starch sample into different 100-ml volumetric flask, add 1 ml of 1N acetic acid and 2 ml of iodine solution to each differently and make each up to 100 mL with distilled water. Shake for 20 min on a rotary shaker and take absorbance at 620 nm utilizing UV/VIS spectrometer. Replicate the procedure for both samples.

2.5 Morphological Properties

Scan electron Micrographs for both native and modified sample were obtained with a scanning microscope (JOEL 6060LV version). The starch samples images were captured within the amplification ranges of 300 and above and 15KV working voltage.

2.6 Fourier Transform Infrared (FTIR) Spectra

The Instrument was turned on and allowed to warm-up for 10-15 minutes and likewise the computer system for initialization. Double click on 'MicroLab PC window' icon and wait for it to open. Click on start button to initiate the sampling operation and select the method i.e. Absorbance or Transmittance to be used. Clean the Crystal with organic Solvent and click next to Check the Crystal and Collecting Background. The sample of about 10-15mg was then placed. For solids sample close and press to make a pellet on top of the crystal. For sample Alignment check for Blue line from Red to Green region for proper sampling and put the sample identity for coding. Click next for sampling. Right click for picking the peaks and select peaks for labeling by dragging to acquire the wavenumbers as well as Transmittance or Absorbance.

2.7 Thermagravimetric Analysis

Ten (10) mg of each sample was put into a TGA dish separately. Along these lines, the samples experience warming at 250C to 8500C with warming rate of 10 K•min−1 and nitrogen gas streams at 20 mL•min−1. Record for each sample was taken and their charts drawn.

2.8 Formulation Study

Native and modified starches were used for formulating Paracetamol tablets utilizing wet granulation and direct compression technique.

2.9 Method of Data Analysis

The obtained were analyzed as mean± standard deviation utilizing SPSS factual computer program, form 23.0. The pointer level of significance difference was set at $p<0.05$.

3. RESULTS AND DISCUSSION

The result reported on Table 1 presents reduction in pH for modified FARO 40 rice starch after reacting with sodium trimetaphosphate

(STMP) compared to native starch. The modified FARO rice starch and native starch were not significantly different at ($p<0.05$). The pH reduction in modified FARO rice starch could be as a result of it reaction with sodium trimetaphosphate (STMP). Further pH reduction could be attributed to dilution with HCl solution to pH 4.5 after modification and washing steps applied. The pH for native and modified FARO rice starch obtained from this study were within normal range of 4 – 8 as already detailed [19, 20] utilized in most pharmaceutical and food industries. It is therefore important that the pH of starch tends towards neutrality in order to maximise its uses in industries where products pH changes are undesirable.

The result on Table 1 showed the modified FARO rice starch having decreased moisture content compared to native starch and there was no significance difference at ($p<0.05$) between them. The reduction observed for modified starch might be due to alteration and changes within the big molecular structure of the starch granules caused by STMP. It could also be as a result of the design associated with the response that occurs between the OH groups of glucose units of each starch of the FARO rice or through the bi- or poly-functional chemicals utilized during chemical alteration, diminishing, plausibility of response between starch chains OH units and water particles and subsequently connect water to this polymer [21]. This reduction tread observed in this work is comparable to reduction detailed by [22], on impact of modification on physicochemical, uses and basic features of cassava starch (*Manihot esculenta* Crantz) which shows reduction in moisture content of modified starch as a result of expanded clarity of modified starches. Therefore reducing the moisture

Table 1. Results showing Physicochemical Properties of Native and Modified FARO 40 Rice Starch

FARO 40	Native	Phosphorylated
pH	6.97±0.04b	6.17±0.40b
Moisture content	9.17±0.17b	6.21±0.26a
Ash content	6.93±0.04a	7.54±0.75a
Acidity	3.34±0.30a	9.67±0.88b
Solubility	8.17±0.17a	12.59±0.05b
Swelling Capacity	4.72±0.35a	7.30±0.72b
Gelatinization Temp	80.67±2.33a	75.00±1.73a
Browning Temp	210.67±0.88ab	206.00±3.06a
Charring Temp	216 - 231±1.52a	233.00 - 250±0.58b
Viscosity	1574.03±3.39b	881.27±87.58a
Amylose Content	0.044±0.0003a	0.048±0.00318a

Values are Mean ± SEM of triplicate determinations. Values with different alphabet across a row are significantly different at p<0.05

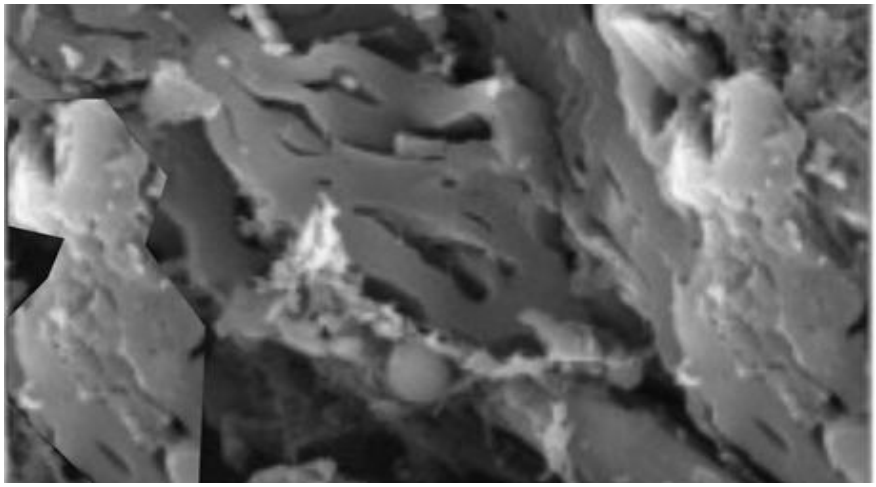

Plate 1a. FARO 40 Native Starch Scanning Electron Microscope image

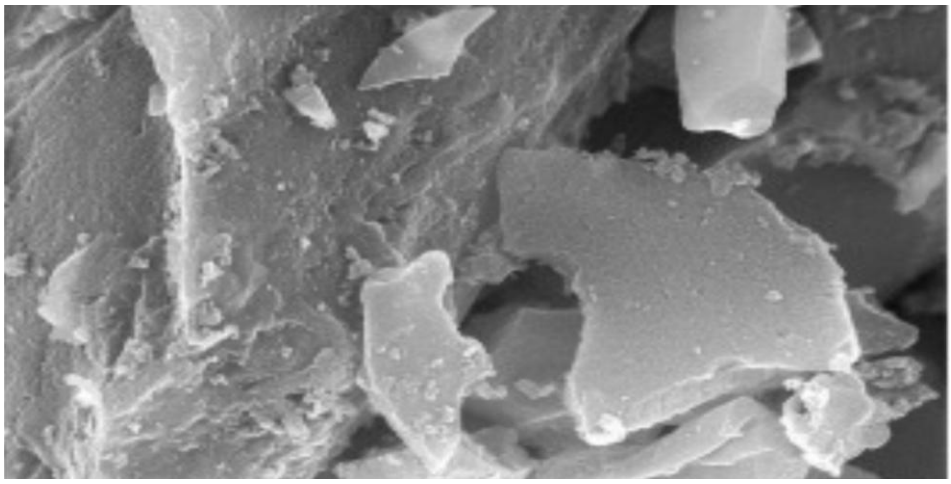

Plate 1b. FARO 40 phosphorylated starch scanning electron microscope image

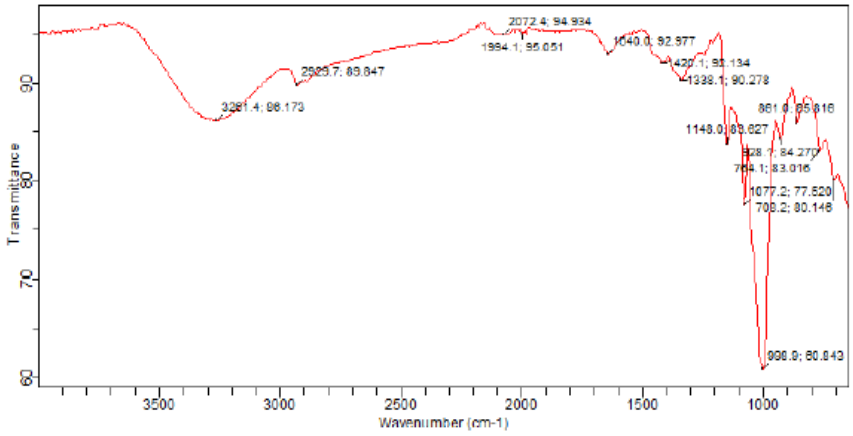

Fig. 1a. FARO 40 native starch fourier transform infrared spectroscopy spectral

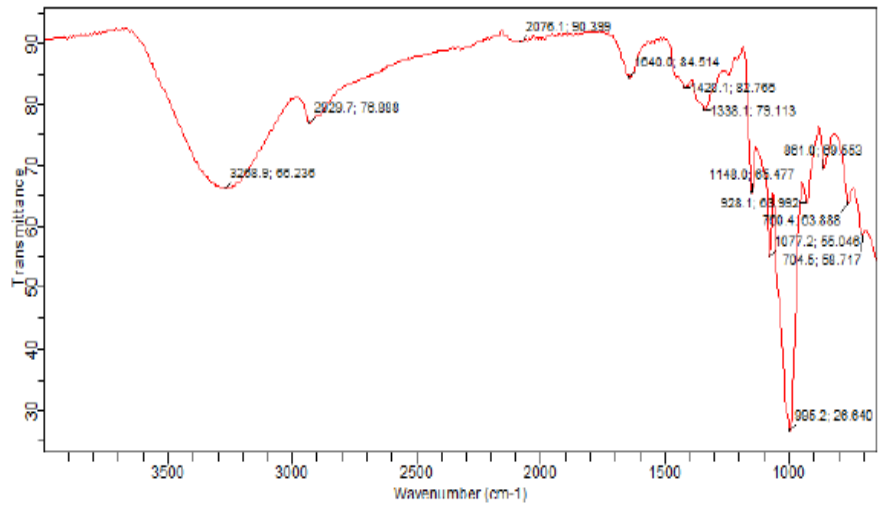

Fig. 1b. FARO 40 phosphorylated starch fourier transform infrared spectroscopy spectral

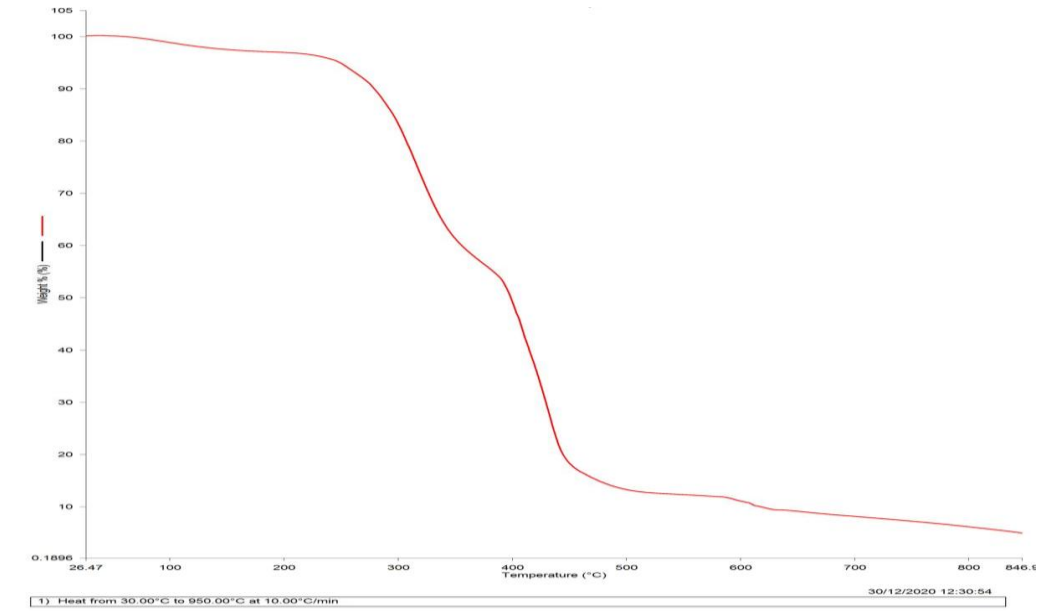

Fig. 2a. FARO 40 native starch thermogravimetric analysis plot

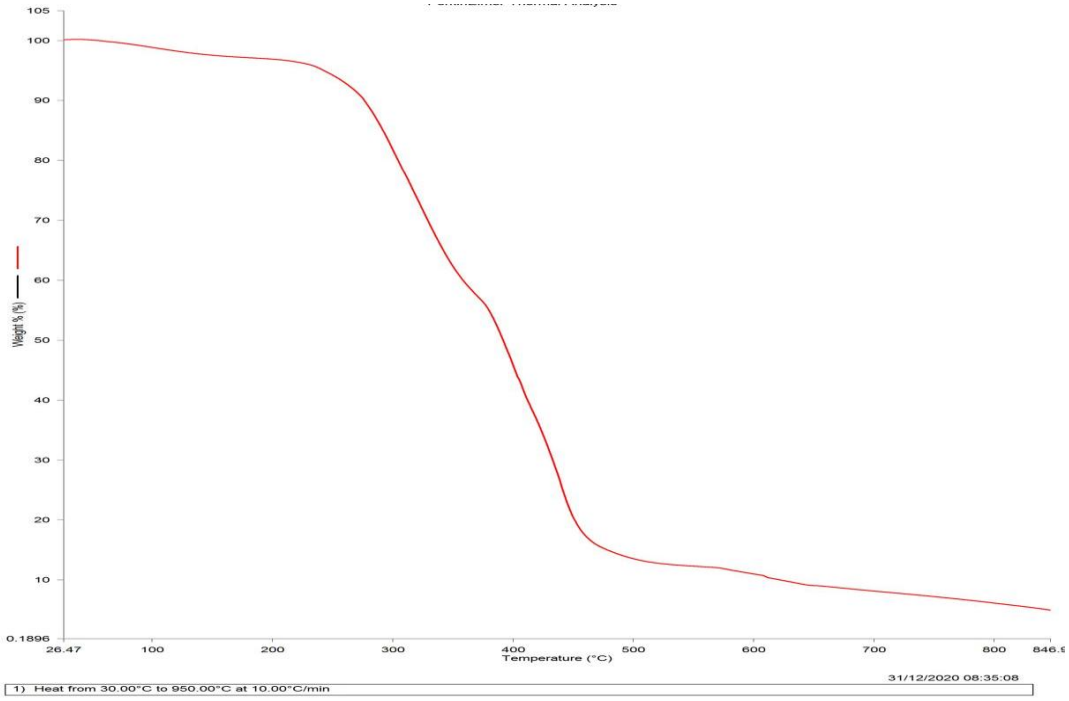

Fig. 2b. FARO 40 phosphorylated starch thermogravimetric analysis plot

content of native starch by chemical modification could prolong shelf stability during storage and help to keep the quality of the starch by preventing the growths of mould during storage [23].

The result on ash content of native and modified starch shown on Table 1 indicates increased in ash content for modified compared to native FARO 40 rice starch variety. Significance difference at ($p<0.05$) wasn't observed between them. This result corresponds with that of [8,24] observed that modified starch had higher ash content than native starch.

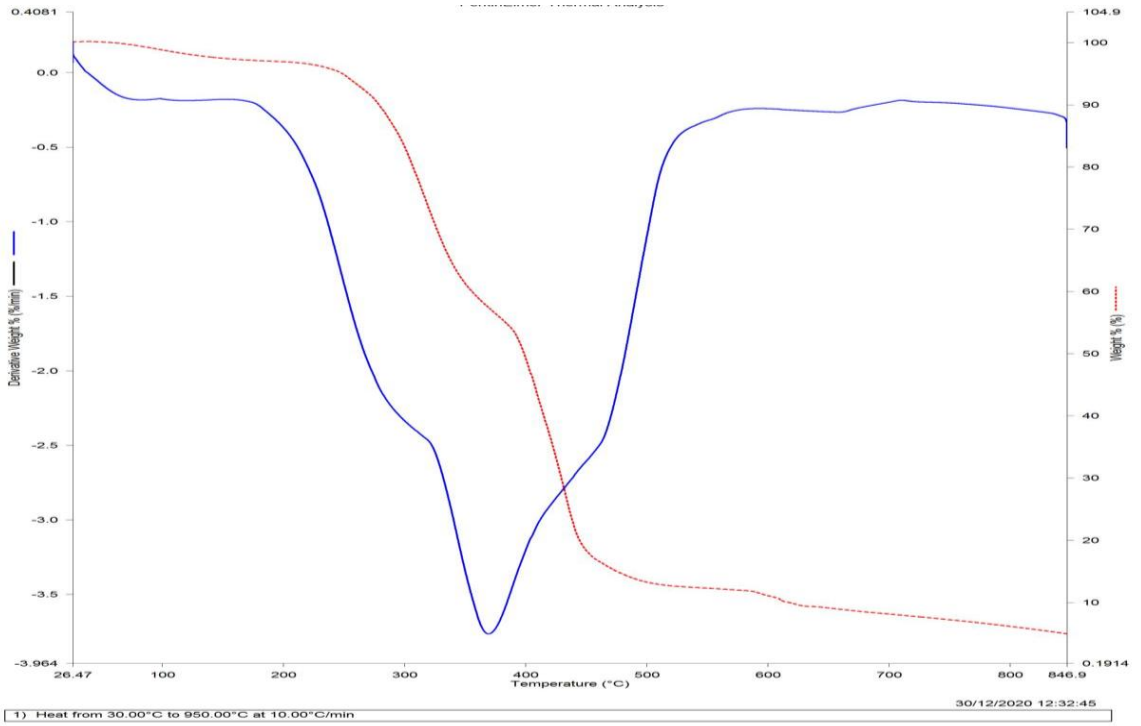

Fig. 3a. FARO 40 Native Starch Derivative Thermogravimetric Plot

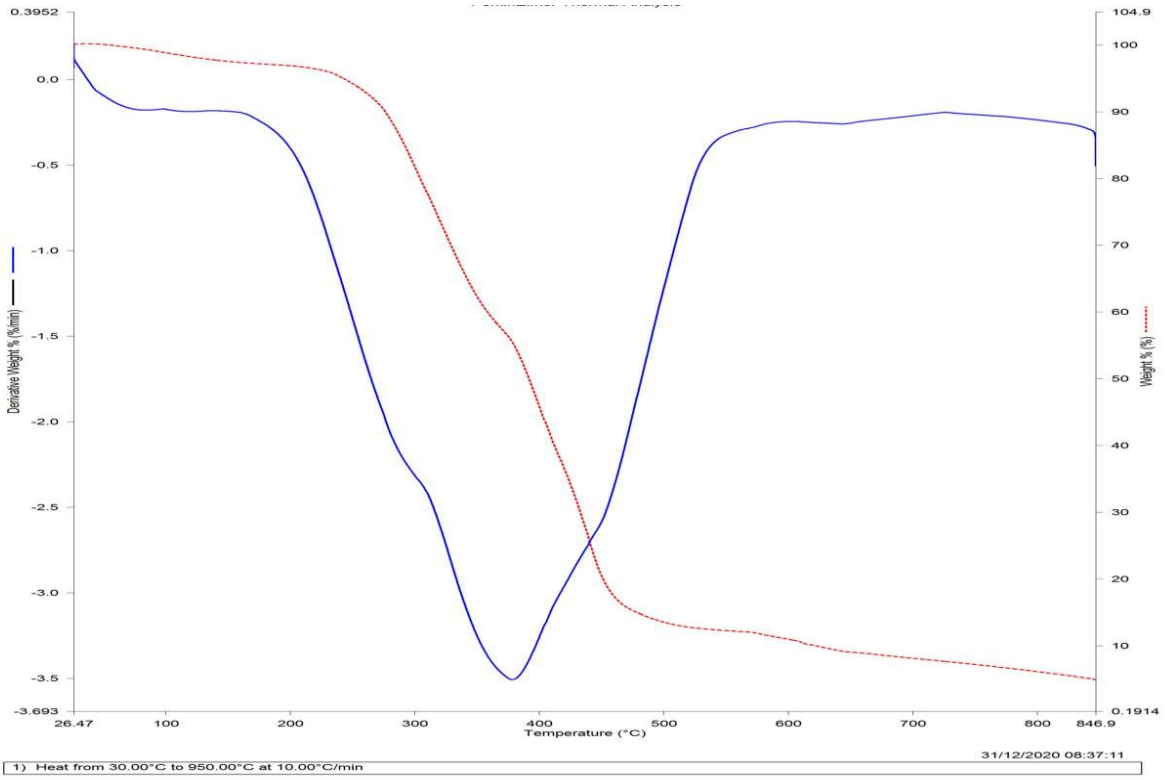

Fig. 3b. FARO 40 Phosphorylated Starch Derivative Thermogravimetric Plot

Table 2. Results showing the Certificate of analysis for Paracetamol Tablets from FARO 40 (N and P) and Standard Maize Starch

Specification (B.P)	Parameters	FARO N40	FARO P40	Maize Starch
625 (mg)	Max. Wgt	580±2.54	621±3.08	619±2.11
565 (mg)	Min. Wgt	565±2.11	570±3.09	568±3.11
NLT 3 (kg/cm^2)	Hardness	4.0±0.05	5.0±0.06	5.5±0.10
NMT 1 (%)	Friability	0.91±0.23	0.86±0.10	0.65±0.05
3.8-42 (mm)	Thickness	4.1±0.00	4.0±0.00	4.0±0.00
NMT 1-5 Mins (s)	Disintegration Time	165±0.09	141±0.23	121±0.15
NLT 70 (%)	Dissolution	73±2.34	81±0.00	81±0.00
95%-105 (%)	Assay	98±0.00	98±0.00	101±0.00
1.5 – 2.5 (%)	Loss on Drying of the Granules	2.43±0.00	2.00±0.00	1.86±0.00
NLT 65 (%)	Coarse of the Granules	65.85±0.00	67.43±0.00	66.71±0.00

The solubility of modified starch was higher than that of the native starch as shown on Table 1. The introduction of phosphate groups into native starch structure weakened the hydrogen bonding between the molecules in the starch granules resulting in higher solubility of phosphorylated starch. Modified starch showed Significance difference at ($p<0.05$) from native starch. The work of [25,26] on impact of acetylation and carboxylation on physicochemical properties of cassava starch shows solubility of cassava starch increments. Therefore, increased solubility could suggest modified starch to have increased digestibility and ability to use starch in solution for industrial use.

Table 1 shows increase in swelling capacity of modified FARO 40 rice starch compared native starch. The increase observed in modified starch could be due alteration within the glucose granular structure that makes up the starch which permits water to enter easily. Additionally, it might be ascribed to tight squeezing of molecules within the granule. Significant difference at ($p<0.05$) in swelling capacity for modified FARO rice starch was observed as compared to native starch. The following people [27-29] observed that cross-linked starch has higher swelling capacity than native starch at increased temperature.

Gelatinization temperature of modified FARO 40 rice starch was observed to be lower compared to native starch as shown on Table 1. This might be due to weakening intermolecular qualities and introduction of phosphate groups into the starch structure. Significance difference was not observed between modified and native FARO starch. This is comparable to work done by [26, 7, 30], on modification effect on starch from yam and sweet potato where they observed reduced gelatinization temperature of starch. Therefore the stronger the intermolecular bond between the starch molecules the more heat is needed to break it and the higher the gelatinization temperature. Thus, phosphorylation suggest to be effective in starch modification that helps in gelatinization temperature reduction.

Charring and browning temperature of modified starch for FARO 40 were higher compared to native starch as shown in Table 1. Significance difference was observed between native and modified starch for FARO 40. This could suggest that modified starch can be heated to higher temperature without change in colour or charring that can make starch better for industrial utilizations at higher temperatures. This is similar [19] work on preparation and physicochemical characterization of icacina starch citrate – a potential industrial starch.

The viscosity values for modified FARO 40 rice starch appears to have basically diminished compared to the native starch and it shows significance difference at ($p<0.05$) level. This diminish could be due to the introduction of phosphate groups through treatment with sodium trimetaphosphate (STMP) that might have diminish or may completely maintain a strategic distance from granule swelling which results in reduction in thickness or consistency. This is comparable to the work [28], who expressed that the consistency conduct of crosslinked (phosphoryl chloride) experiences an unfaltering decrease in viscosity. The [12] modification of cassava starch for mechanical livelihoods indicates decrease in thickness compared to the un-modified starch at varying temperatures.

Table 1 presents amylose content for native FARO 40 rice starch to be lower than that of

modified starch and there wasn't significance difference between them at $p<0.05$. The increase in amylose content of the modified FARO rice starch may be related to an expanded formation of dextrins and presentation of phosphate bunches within the course of corrosive treatment. These perceptions were steady with previous reports on increase in amylose content upon starch modification from Canavalisensiformis [29]. This was different to work done by [30], for phosphoric acid impact on physicochemical, useful, and basic properties of starch extricated from yam (Dioscorearotundata) were their findings revealed that the use of phosphoric acid as modifying agent of starch reduces it blue value and amylose content. Amylose content is significant in almost all starch because higher amylose starch have increased retrogradation tendencies

Scan electron microscopy results for FARO 40 native and modified rice starch are shown on Plate 1 and 1a respectively. Starch images for native FARO 40 rice starch shows clustered, smooth, and specific granular shapes compared to modified starch which shows rough and cruel surfaces. In any case, the changes observed on starch granules surfaces for modified starch could be due to sodium trimetaphosphate reactions and the hydrochloric acid used to reduce the pH. The [30] previous research revealed similar surface roughness on maize and potato starch granules for phosphoric destructive alteration. Therefore, granule shape of starch impacts it valuable characteristics such as starch gelatinization, swelling and thickening rate which influences their applications.

Native and modified FARO 40 starch FTIR results are shown on Fig. 1a to 1b. Native starch discernable peaks are observed at 3261.4 which are credited as O-H stretched bonds. The peaks came as a result of hydroxyl (O-H) and C-H bunches vibration, exclusively comparable to [31] native starch results. Other peaks were observed at 2929.7 as C-H stretch (Alkanes), 1640 corresponds to C=C expand (alkenes) and C-O amplify, 1148 and 1077.2 corresponding to C-O amplify. Another top band seen on at 708.2cm-1 for native starch as C-H bend. After modification, bands intensity increases between 1148 and 1077.2cm-1, as signs for C-O bonds formed through the substitution of hydroxyl with phosphate groups which was communicated by [23]. Assimilation peaks were observed within modified starch. Intensity of absorption bands for O-H was at reduce rate for modified starch compared to native starch. Bands like C-O, C=C, and C-H for modified starch were at increased intensity when compared to native starch for FARO 40 rice variety. Absorption bands intensity increase could be due to collapsing of the C-O, C=C and C-H bands resulting in changes within starch structures [32,33].

FARO 40 native and modified rice starch were thermogravimetrically inspected for thermal stability and decomposition characteristics. Thermogravimetric analysis investigated starch-based materials utilized for industrial purposes on their degradation and thermal behaviour. Thermogravimetric graphs and derivative thermogravimetric graphs are shown on Figs. 2a, 2b, 3a, and 3b for native and modified rice starch respectively.

The graphs shows similar trend, indicating thermal breakdown and mass loss for native and modified starch occurring at different phases representing particular event during heating. Thermal action occurs first between 100^0C and 150^0C for native and modified starch which results in mass loss due to moisture and water fragments elimination by evaporation. In this phase, higher moisture content leads to higher mass loss.

Continuous heating leads to another lost in weight between 250°C and 460°C. At this weight lost, modified starch has higher temperature compared to native starch within the region of 390^0C. This phase reduction in weight is related to depolymerisation and degradation of starch structure carbon chain.

Weight lost finally occurs within the range 460^0C and 700^0C. Weight lost at these temperatures are not prominent compared to the one between 250°C and 460°C due to evaporation of less materials or water from native and modified starch which shows that modification hasn't altered thermal stability of modified of starches. The report of [34] on effect of different plasticizers shows rate of degradation between 290.9^0C and 295.4^0C.

The values of the weight of paracetamol tablets formulated with FARO 40 Native starch and modified starch ranges from 565 – 620±5% mg as shown on Table 2. The values were within British pharmacopeia limit for particular tablet weight. British Pharmacopeia determination states "for tablets weight > 500 mg, ± 5 % weight variety are permitted". It implies that tablets

formulated from native and modified starch as binder passes weight consistency test when compared to consistency weight results for tablet defined with maize standard starch. The die cavity uniform filling resulted from great stream properties of granules moreover improved by the addition of Glidant. The report of [35] expressed that variety within weight for individual tablets may be a substantial sign for comparing variety within sedate substance.

Index used to measure tablets hardness is called Crush strength. Van der Waal‟s attraction forces, frictional, mechanical powers, and strengths are due to arrangement of strong bond serves as binders that held together the tablets [36]. The results of smashing quality of tablets defined with native, modified and standard maize starch are presented in Table 2. Native starch has crushing strength between the ranges of (4.0), modified has between the ranges of (5.0 – 5.5) and standard maize starch has crushing strength of (5.5). Modified starch recorded the highest smashing quality when compared with smashing quality of native starch.

The results indicates that the values of crushing strength for all starch are within restrain indicated by British Pharmacopeia which stated that smashing of tablet ought not be less than 3.0kg/cm^2. This is comparable to outcome for [36] who worked on the smashing quality of tablets defined with *Plectranthus esculantus* starch. This demonstrates that FARO 40 rice starch either native or modified form has superior crushing quality when utilized for tablet definition as a binder.

The degree of the shortcoming of tablets is friability (FR); it gives a sign of the likely edge harm that would happen when the tablets are taken care of amid bundling, transportation and apportioning. In any case, none of the starch has it friability esteem over the constrain as indicated by [37] where it was stated that friability ought not to be more than 1% for each tablet. These shows that tablets defined with both native starch and phosphorylated starch has exceptionally great binding properties when compared to standard maize starch and other starches utilized ordinarily as binders and disintegrant.

Disintegration time result for tablets formulated from native starch, modified starch and standard maize starch are presented in Table 2. Modified starch deteriorates quicker than native starch and this diminish within the sum of starch amylose content. The disintegrating time values for both native and modified starch are within recommended ranges indicated by [37]. These suggests tablets defined from native starch and modified starch as binders passed disintegration test when compared to crumbling values of tablets defined from standard maize starch. These perpetually imply that FARO rice starch either as native or modified form can serve as excellent excipient to be utilized as binder or disintegrant in Tablets detailing. These outcome are comparable to discoveries of [38] which includes a deterioration limit extending between 1-5 minutes.

Dissolution profile results for tablets defined from native starch, modified starch and standard maize starch as binder at distinctive time interim are presented on Table 2. At 70 minutes, disintegration time for native starch and standard maize starch are factually and significantly different from disintegration time for phosphorylated starch.

The disintegration effectiveness (D.E.) which is the rate of medicate discharged after 70min were more noteworthy than 70 % for native starch, modified starch and standard maize starch. All tablets passed British Pharmacopeia (2015) disintegration test, which states that at least 70% of the drugs ought to be discharged after 45 min. The results shows disintegration for tablets defined from FARO 40 rice starch for both native, modified and standard maize starch agrees with the crumbling – disintegration hypothesis which demonstrates that deterioration more often than not play a crucial part in disintegration handle which decides to an expansive degree the region of contact between strong and fluid media [39]. The report [40] presents a comparable result on impact of warm and chemical alteration on industrial and discharge properties for paracetamol tablets defined from corn, cassava and sweet potato starch which present disintegration values extending from 70-90% which is comparative to the disintegration values gotten from tablet formulated from native and modified FARO 40 rice variety starch at 70 minutes. This implies that both native and modified FARO 40 rice variety starch are good binders and disintegrant in tablet formulation.

4. CONCLUSION

Rice is one of the foremost important but adaptable nourishment fixings values having included properties for endless industrial uses.

This particular grade of rice was used because of its low physiochemical and morphological properties that is why it was modified for use. The research entails the use of chemically modify underutilized rice variety using standard methods for possible use as pharmaceutical grade starch. Chemical modification has shown to improve the physicochemical and morphological properties of the three FARO 40 underutilized Nigerian rice varieties for pharmaceutical purpose.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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