



ABSTRACT

Natural coagulants are considered affordable and efficient substitutes to chemical coagulants for use in developing countries where raw materials such as *cicer arietinum* (green pea) are readily available. Polluted water is estimated to affect about 1200 million people and contribute to the death of 15 million children in the world per year. The excessive use of chemical coagulants can affect human health in the long term; aluminum has been indicated

EFFECT OF STORAGE CONDITION OF PEA POD ON WATER SOFTENING

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Introduction

According to a survey conducted by united nations environmental program; 20% of world's population lacks access to safe drinking water, and 50% lacks access to safe sanitation (who, 1997). In addition, polluted water is estimated to affect about 1200 million people and contribute to the death of 15 million children in the world per year (who, 1997). The use of natural materials of plant origin to treat impure raw waters is not a new idea. Natural water treatment materials have bright future and are concerned by many researchers because of their abundant source, low price, environment friendly, multifunction, and biodegradable nature in water purification (madhavi et al., 2013). The use of natural material softener in water treatment has been used for domestic uses, while the softening removes calcium & magnesium ions (the hardness) from water by the virtue of the temperature and the ph level. Recent research found that the presence of bioactive compounds (chemical and extra nutritional constituents) in pea pod is equal to the bioactive compounds present in pea cotyledon or seed (Saha et al., 2014).



to be a causative agent of neurologic diseases such as senile dementia. researches confirms the high impact of pea pod as a softener in water treatment, but much researches have to be done to ascertain the effects of its storage on water softening. Therefore, the research aims at finding effect of **storage condition (temperature and ph) effect of pea pod on water softening.** a suitable method was employed for the pea pod processing. Pea pod was prepared and ground to powder. Phytochemical analysis of the pea pod was done. 10% stock solution of the extract was prepared, jar test for water softening, was carried out for high, medium, low untreated synthetic waters, kura surface (river) water and zoo road well water, the process was repeated for stored pea pod powder at varying temperature and ph values. Hardness removal, by the filtrates, increased with increase in initial hardness. Also, ph increase of pea pod towards alkalinity causes significant increase in hardness, while temperature increase increases the rate of hardness removal; p-values range was high, signifying that there is significant difference between the percentage hardness removal of pea pod powder not stored and that stored for the varying temperature and ph values.

Keywords: Pea Pod, Softening, Water Treatment, Storage Condition And Ph

Also, researches confirm the high impact of pea pod as a softener in water treatment, but much researches have to be done to ascertain the effects of its storage condition on water softening. Therefore, the research aims at finding **EFFECT OF STORAGE CONDITION (TEMPERATURE AND PH) EFFECT OF PEA POD ON WATER SOFTENING.**

METHODOLOGY

WATER SAMPLES

The synthesized water was prepared at the public health laboratory. The water quality parameters were checked before and after treatment. Doses of the pea pod filtrates i.e. 0.25ml, 0.5ml, 1.0ml, 2.0ml and 3.0ml, 5.0ml and 7.0ml (Aweng et al., 2012) were chosen so as to get the corresponding final concentrations. WHO 2018 standard for turbidity is 5ntu.

PEA (CICER ARIETINUM) POD SAMPLING AND PHYTOCHEMICAL ANALYSIS

Good quality fresh pod of the peas will be selected manually and randomly (in accordance with Kwaji et al., (2010) from the market, and will be authenticated from the department of botany and dried under room temperature for two weeks.



Complete proximate standard procedure analyses of the pea pod were done in the department of animal science and also in biochemistry department Bayero University Kano, Nigeria.

The following materials and equipment's were used throughout the tests: 10 liters of synthesized water: pure water with 7.0 PH, 10 (500-1000ml) beakers, electric stirrers, pipettes, sieves (200-500mm), standard PH meter, thermometer, turbid-meter, clinical auto-clave, autoclave or biosensor machine for bod test, photometer, 10-20 normal test tubes, 500-1000g kaolin bentonite, 1 complete pack of whatman filter papers, 50,000mg of calcium chloride dehydrate ($\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$), jar test apparatus, incubator, oven, 2ml buffer solution, Erichrome T indicator and EDTA standard titrant, 0.1N HCl and 0.02N NaOH, Gallenkamp water bath and controlled fridge etc.

PREPARATION OF PEA POD POWDERS AND CRUDE EXTRACTS

The dried pods were separately grounded to fine powder using domestic blender. The ground powders were then sieved through a 210 μm sieve. The extraction was in accordance with Aweng *et al.*, (2012), but was mixed with a different mixer: crude extracts was prepared by using 500ml of distilled water to 50g of the prepared powder, which was mixed by a British made (RPM=1400, HP=1/86, watt=8.6) stirrer for 60min and left to settle for 20 minutes to make 10% stock solution of the pea pod extract. The crude extracts were finally filtered through whatman filter paper. The filtrates were prepared at the time of conducting the tests, since deterioration sets in, with delay (Muyibi *et al.*, 1994). The filtrates were used within 48 hours.

PREPARATION OF SYNTHETIC WATER

Synthetic raw water was prepared to guarantee the homogeneity of raw water to be used with specific concentrations.

DETERMINATION OF HARDNESS OF WATER BY EDTA TITRATION METHOD

Synthetic hard water was prepared in accordance with USAID *et al.*, (2014), but with different softener concentrations: this was prepared with the help of calcium chloride dehydrate ($\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$). Concentrations of 300mg/l, 500mg/l, 700mg/l and 900mg/l were used for this experiment. Stock solution of 1000ml was prepared for each different concentration. Calcium chloride dihydrate has a molecular weight of 147.02; hence 441mg (that is 120mg of Ca^{2+}), 735mg (200mg of Ca^{2+}), 1029mg (280mg of Ca^{2+}) and 1323mg (360mg of Ca^{2+}) (calculated using equation 1) of it was added in a liter of de-ionized water which gives 300ppm, 500ppm, 700ppm and



900ppm respectively (Kevin, 1999 and Vernier software & technology). 300ml of the stock solution was distributed in three different beakers of 500ml capacity. Pea pod filtrates of 333, 500 and 835mg per liter of water was added separately in different set of three beakers. (Water Softening, Precipitation Softening, info@ewp.rpi.edu, 2016, 9-Softning_F12; Kevin, 1999)

$$\text{Hardness (mg/l as } \text{CaCO}_3) = (\text{mg/l of } \text{Ca}^{2+}) \times \frac{\text{eq. wt of } \text{CaCO}_3}{\text{eq. wt of } \text{Ca}^{2+}} \dots\dots\dots \text{equ. 2.1}$$

Where

eq. wt of $\text{CaCO}_3 = 100$; and

eq. wt of $\text{Ca}^{2+} = 40$

PROCEDURE FOR LABORATORY ANALYSIS

Phytochemical analysis was firstly conducted on the pea pod of the plant to confirm the presence of chemical and bioactive constituents of pea pod that was responsible for the water treatment. Level of contamination of the synthetic water was determined. the synthesized water was separately treated using pea pod filtrates. The test was carried out batch wise. Three water samples were mixed each homogeneously with the chosen doses of pea pod extract and then allowed to rest. The treated water samples were then analyzed to determine the levels of softening, temperature and PH.

HARDNESS TEST

50ml of water sample was measured into a clean beaker followed by addition of 0.5ml of 0.1n HCL to the sample. The mixture was heated to expel CO_2 . It was cooled to 50°C and mixed with 2ml of buffer solution of pH 10. Two drops of Erichrome T indicator were added and the solution was titrated with EDTA standard titrant until the color changed from wine red to blue. The volume of EDTA used was recorded and the procedure was repeated for the remaining samples. Hardness of water was calculated using the formula below (BUK civil engineering laboratory manual for 500l; APHA, 1999):

Also, hardness meter was used to justify the exact result.

$$\text{Hardness (as mg/l } \text{CaCO}_3) = \frac{(\text{vol of EDTA titrant}) * f * 1000 * 0.1 * 17.8}{\text{ml of sample}} \dots\dots\dots \text{equ.2.2}$$

Where $f = 1$

TEMPERATURE VARIATION WITH TURBIDITY AND PH

Jar tests was completed for optimum doses for High turbidity, Medium and Low turbidity of pea pod extract at 40, 30, 20, 10, 5 and 0.5°C but with slight variation starting from 0°C to 50°C . The procedure for the jar test was stated already in



section above. Gallenkamp water bath and a controlled fridge were used to control temperature (and they were different from instruments used in the referenced method).

Also, pH values were taken throughout the tests.

The whole procedure was repeated for varied temperature and pH.

TABLE 1.0: TEMPERATURE RANGES WITH PH, TURBIDITY REMOVAL EFFICIENCY (%), % SOFTENING, % DISINFECTION

TEMPERATURE (°C)	PH	TURBIDITY REMOVAL EFFICIENCY (%)	% SOFTENING
40			
30			
20			
10			
5			
0.5			

RESULT AND DISCUSSION

EFFECT OF THE PEA POD EXTRACT ON PH OF WATER

The initial pH values of the water samples were 6.7, 6.8, 6.9, 6.7 and 6.9 respectively for high, medium and low, Kura open channel surface (river) water and Zoo road underground (well) water turbidities, and the initial pH of the pea pod extract was 3.5.

However, when the High, Medium and Low, Kura open channel surface (river) water and Zoo road underground (wells) waters were treated with various doses of the pea pod extract, the pH values changed (towards alkalinity) as shown in figure 3.1.

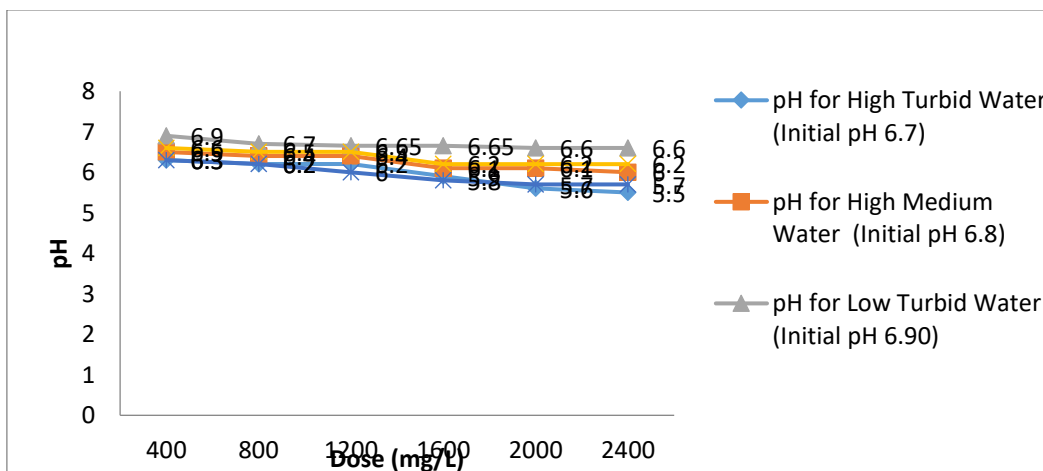


FIGURE 2.1: THE EFFECTS OF DOSES ON PH FOR DIFFERENT WATER SAMPLES FOR PEA POD UNSTORED



At optimum doses (1600mg/l for High, Medium, Low and Kura surface turbid waters and 1200mg/l for Zoo road well water), the optimum pH values after treatment were 5.9, 6.1, 6.65, 6.2 and 6.0 respectively.

In a similar research on water treatment, the pH was observed in alkaline nature after treatment with moringa seed powder, confirmed by the work of Jodi *et al.*, (2012). Musa (2016) in his work discovered a similar pH reduction while treating water with *Poliostigma Thonningischum* and *tamarinds India l.* leaves extracts. Sethupathy (2015), in his work, discovered a similar pH reduction while treating water with *moringa oleifera* seed powder. Also Chadanand and Manika (2015) observed pH shift to slightly alkaline nature after treatment with pea seed powder.

Although the pH of the water varied as a result of the introduction of the plant extracts, it was within the range set by who 2018 standard for drinking water i.e (6.5-8.5).

TABLE 2: COMPARISON OF RESIDUAL HARDNESS (MG/L) WITH SOFTENER DOSE IN (MG/L) FOR PEA POD

SOURCE	DOSES (MG/L)						
	INITIAL HARDNESS (MG/L)	400	800	1200	1600	2000	2400
	TEMPERATURE IN °C						
	0	10	20	30	40	50	50
RESIDUAL HARDNESS (MG/L)							
SYNTHETIC HARD WATER (MG/L)	300	286	255	-	-	-	-
	500	370	240	-	-	-	-
	700	419	210	25	-	-	-
	900	436	202	42	-	-	-
KURA OPEN CHANNEL SURFACE HARD WATER (MG/L)	298	281	225	25	5	-	-
ZOO ROAD UNDERGROUND (WELL HARD WATER (MG/L)	465	411	295	185	50	10	-

TABLE 3: COMPARISON OF % HARDNESS REDUCTION WITH SOFTENER DOSE IN (MG/L) FOR PEA POD

SOURCE	DOSES (MG/L)						
	INITIAL HARDNESS (MG/L)	400	800	1200	1600	2000	2400
	% HARDNESS REDUCTION						
SYNTHETIC HARD WATER (MG/L)	300	4.67	15	100	100	100	100
	500	26	52	100	100	100	100
	700	40.14	70	96.43	100	100	100
	900	51.55	77.55	95.33	100	100	100
KURA OPEN CHANNEL SURFACE HARD WATER (MG/L)	298	5.70	24.49	91.61	98.32	100	100
ZOO ROAD UNDERGROUND (WELL HARD WATER (MG/L)	465	11.61	36.56	60.21	89.25	97.85	100



The table shows that, hardness removal initially varies directly with temperature from 0.5°C to 20°C, with some little deviations at 5°C, until it reached maximum at 30°C for High, Medium, Low and Kura surface turbid waters and 20°C for Zoo road well water. It then began to vary indirectly.

Hardness removal of the pea pod increases drastically when the temperature was increased towards 50 degree. This shows that temperature of the pea pod has optimum temperature at 50. Rasha (2014) even argued that low temperatures would impair floc formation because of increased shear stress due to higher water viscosity. according to them, the effect of temperature on the best flocculation time required for efficient sedimentation becomes less when temperature increased to 25°C, and little difference in flocculation times at temperature range from 10 to 25°C, while much higher differences at temperatures less than 10°C.

TABLE 4: COMPARISON OF PH VALUES WITH SOFTENER DOSE IN (MG/L) FOR PEA POD

SOURCE		DOSES (MG/L)					
		INITIAL HARDNESS (MG/L)	400	800	1200	1600	2000
		PH VALUES					
SYNTHETIC HARD WATER (MG/L) (PH=7.2)	300	6.7	6.7	6.5	6.5	6.5	6.45
	500	6.9	6.9	6.9	6.9	6.9	6.85
	700	6.7	6.65	6.4	6.4	6.4	6.35
	900	6.7	6.6	6.0	6.0	6.0	5.95
KURA OPEN CHANNEL SURFACE HARD WATER (MG/L) (PH=7.1)	298	7.1	7.1	7.1	7.0	7.0	6.9
ZOO ROAD UNDERGROUND (WELL) HARD WATER (MG/L) (PH=7.1)	465	7.1	7.1	7.0	6.9	6.9	6.9

At optimum doses (1600mg/l for High, Medium, Low and Kura surface hard waters and 1200mg/l for zoo road well water), the optimum pH values after treatment were 5.9, 6.1, 6.65, 6.2 and 6.0 respectively.

High acidity shows promising increase in softening activity of the pea pod, while high alkalinity decreases softening activity.

In a similar research on water treatment, the pH was observed in alkaline nature after treatment with moringa seed powder, confirmed by the work of Jodi *et al.*, (2012). Musa (2016) in his work discovered a similar pH reduction while treating



water with *poliostigma thonningischum* and *tamarinds India I.* leaves extracts. Sethupathy (2015), in his work, discovered a similar pH reduction while treating water with *moringa oleifera* seed powder. Also, Chadanand and Manika (2015) observed pH shift to slightly alkaline nature after treatment with pea seed powder.

Although the pH of the water varied as a result of the introduction of the plant extracts, it was within the range set by who 2018 standard for drinking water i.e (6.5-8.5).

The interaction of the pod filtrates with chemical and other substances in raw water are not extensively understood and the products of interaction are not all known to this work. However, since pea pod is less acidic, pH could be believed to have a vital role on softening activity of the pod: the lower the acidity, the higher the softening activity.

Muyibi et al., (1994) in his research in treating synthetic hard water using *moringa oleifera* seed found that there was a threshold *moringa oleifera* dosage concentration of 650-750 mg/l and that the mechanism for hardness removal was adsorption, with adsorption isotherm approximately the Langmuir type, and conversion of soluble hardness-causing substances to insoluble products by precipitation. they found that the efficiency of softening hard water with *moringa oleifera* seeds to be independent of pH and alkalinity but dependent on the permanent hardness of the four raw water sources used. this is supported by the work of Padmapriya et al., (2014) which revealed that *moringa oleifera* seeds were effective in removing water hardness.

CONCLUSION AND RECOMMENDATION

The optimum pH values after treatment were 5.9, 6.1, 6.65, 6.2 and 6.0 respectively which were within the range set by who 2018 standard for drinking water i.e. (6.5-8.5).

pH increase of pea pod towards alkalinity causes significant increase in hardness. Hardness removal, by the filtrates, increased with increase in initial hardness. For synthetic hard water; for 300mg/l and 500mg/l hard water, optimum dose was at 1200mg/l; for 700mg/l and 900mg/l, optimum dose was at 1600mg/l; for 298mg/l Kura surface hard water, optimum dose was at 2000mg/l; for 465mg/l zoo road well water, optimum dose was at 2400mg/l in terms of % hardness removal. But for standard drinking water, optimum dose was 800mg/l.

While temperature increase, increases the rate of hardness removal.

The research recommends; comparative research should be done on the efficiency of the different methods of pea pod extraction. Also, research should do on the



efficiency of pea pod as an adsorbent and heavy metal removal in waste water treatment.

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