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Viscosity Drop of TKP Based Thickener due to Hydrolytic Activity of Some Indigenous Micro Flora

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ABSTRACT: Thickeners prepared from natural sources like the pulverized seeds of Tamarind and Guar, and also Xanthan find application in different industries like textiles, food processing and pharmaceutical works. These thickeners are preferred over the synthetic thickeners due to their low cost of production and abundant availability, which leads to comparatively low cost of production compared to the synthetic products. These natural thickeners are easily biodegradable without causing any harm to the environment, which is the burning problem of the day. These thickeners suffer from hydrolytic degradation due to the development of micro flora at acidic pH. The thickener paste starts losing its viscosity and the paste becomes watery after some 48 hours of its preparation. Out of all these thickeners, Tamarind Kernel Powder or TKP is widely used due to its abundant availability at low cost. This work has been focused on the incorporation of some natural preservatives in textile grade TKP like *Azadirachta indica* powder, *Calotropis* species powder, *Nerium* species powder, as well as chemical preservatives like p-chloro m-cresol, Sodium azide, Zinc chloride; which helps in maintaining the viscosity for a longer duration.

KEYWORDS: Tamarind, Guar, Xanthan, Thickener, Preservatives, Viscosity.

I. INTRODUCTION

Different types of thickeners like, Tamarind thickener, Xanthan thickener and Gaur thickener are widely used in different industries like Textile Manufacturing, Textile Processing and in Pharmaceutical and Food Processing works. In textile manufacturing it is used in sizing to impart strength to the yarn which is then able to withstand the mechanical stresses encountered during weaving. Use of these thickeners in textile processing mainly includes printing and to some extent in dyeing as an anti-migrating agent where water insoluble dyes are used during thermosol dyeing process. The thickener paste functions as a carrier of water soluble as well as insoluble dyes on to the fabric, which are then fixed in to the fabric after proper heat fixation thermosol application. Thickeners are often used to provide proper texture, control of moisture, water mobility, improve product quality, stability and reduce cost. In food industry it is used as a filler to increase the consistency of the final product like icecreams which melt slowly compared to that of the non additive variety [12]. In pharmaceuticals, thickeners work as a binding agent to carry the generally water insoluble drug powders to the target area in the body of the patient without it getting dispersed or wearing-off in the surrounding atmosphere [10]. Out of all the natural thickeners, Tamarind Kernel Powder, also known as TKP, is widely used due to its abundant availability and being cheap compared to the rest of the other varieties.

1. Chemical Composition of TKP:

Tamarind seed constitutes about 30-34 % of the whole fruit weight. Seeds are important source of carbohydrates, protein, fat and valuable amino acid.[2]. The general composition of TKP is:

Proteins	12.7 - 15.4	%
Oils	3.0 - 7.5	%
Crude fibers	7.0 - 8.4	%
Carbohydrates	61.0 - 72.2	%

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Ash Content 2.45 - 3.3 %

Tamarind seed is a polysaccharide with molecular weight 52350 Daltons and constitutes mainly of three sugars in the molar ratio, Glucose : Galactose : Xylose = 3:2:1 [3].

2. Characteristics of TKP Based Thickener:

Tamarind seed powder is a high molecular weight polysaccharide, and has a good water solubility, hence it finds a wide range of application in food industries, textile industries, and pharmaceutical industries [12]. TKP easily disperses and dissolves in water and under appropriate conditions lead to an increase in its viscosity [9].

This viscosity property is generally considered as one of the important parameter for TKP in textile and other industries due to its significant thickening, suspending, emulsifying, film forming and gel forming properties, which are required during the manufacturing stages [2, 4, 5].

The prominent properties of TKP are:

- **Stability:** TKP exhibits a good physico- chemical stability.
- **Viscosity:** Has a good ability to wet and adhere to the internal surface.
 - Viscosity can be defined as the ratio of shearing stress to the rate of shearing, or Viscosity is the measure of the resistance of a liquid to flow.
$$\text{Viscosity} = \text{Shear Stress} / \text{Shear Rate}$$

Shear stress is the resistance of the liquid to flow under the influence of an applied force.
$$\text{Shear stress} = \text{Force} / \text{Area Sheared}$$
$$\text{Shear Rate} = \text{Velocity} / \text{Clearance} [11].$$
- **Compatibility:** TKP has a neutral pH, and hence is quite compatible with other ingredients of printing paste.
- **Film consistency on drying:** The film is elastic and does not chip off easily after drying, which prevents the spreading of dyes [8].

3. Production of TKP:

The production of Tamarind Kernel Powder is done by the following standard steps:

- **Sorting and cleaning of the seeds or kernels:** The kernels are cleaned by specific techniques which discards dirt. The cleaner machine has a trembling and aspirating screen due to which small and large dirt is thrown away.
- **Roasting of the seeds:** It is a very important phase in order to decrease the water content and shell separation from endosperm. It is carried out by roasting at 150 °C for 15 minutes.
- **Stripping or Decoating of the seeds:** Stripping is necessary to eliminate the undesirable shell from the seed as on one hand it does not play any role in imparting viscosity to the paste, but on the contrary due to its larger particle size, it creates print screen mesh choking up problem. This phase is very easy because Tamarind shell and kernel have different hardness, where the shell is dried during roasting it's been brittle than the kernel so the kernels are decoated with minimum mechanical effort.
- **Separation of the decoated Kernels:** Separating tool is designed to separate shell from the kernel and collect it separately by aspiration process.
- **Grinding:** Grinding of the kernels is carried out to obtain a uniformly smooth and fine powdered material [8].

4. Applications of TKP:

Textile and jute industries are the major consumer of TKP because of its good thickening properties which is essential in sizing of the yarn and in dyeing and printing of fabrics. Jute, paper, explosives, plywood, mining, cosmetic, oil drilling, gas, tobacco and other industries also use in various aspects of their production. TKP is also used as cotton wraps, and as a soil stabilizer in mining, manufacturing of paints and production of adhesives [7].

II. MATERIALS AND METHODS

In order to monitor and curb the microbial growth in TKP thickener natural and synthetic preservatives have been incorporated at different concentrations and changes in viscosity and pH were noted.

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Preservatives used:

1) Natural Preservatives:

- i. *Azadirachta indica* powder
- ii. *Calotropis* species Powder
- iii. *Nerium* species Powder

Leaves of these plants were collected from the Botanical Garden and authenticated by the Herbarium of Navsari Agriculture University, Navsari. The leaves were washed and dried completely under sunlight, and then ground in a mechanical grinder to get a fine powder, which was then stored at dry place in a air tight container [6].

2) Synthetic Preservatives:

- i. Para chloro meta cresol (p-chloro m-cresol)
- ii. Sodium azide
- iii. Zinc chloride

Physical and Chemical Properties of Chemical Preservatives			
	p-chloro m-cresol	Sodium Azide	Zinc Chloride
Chemical Formula	C ₇ H ₇ ClO	NaN ₃	ZnCl ₂
Appearance	Brownish transparent crystalline powder	colorless to white solid	white crystalline solid
Odor	Odorless	Odorless	Odorless
Molecular weight	142.58 g·mol ⁻¹	1.846 gm/cm ³ (20 °C)	136.315 gm/mol
Water & NaOH Solubility	0.4% at 20°C: 32% w/w in 10% NaOH at 20°C:	38.9 gm/100 mL at 0 °C 40.8 gm/100 mL at 20 °C 55.3 gm/100 mL at 100 °C	432.0 gm / 100 gm at 25 °C
Solubility in other solvents.	Soluble in many organic solvents like methanol, ethanol, isopropanol, acetone, toluene, benzene, xylene, carbon tetra-chloride.	Highly soluble in ammonia slightly soluble in benzene insoluble in ether, acetone, hexane, chloroform	In alcohol 430.0 gm /100ml

Preparation of TKP Thickener:

Thickening agent was prepared according to the following steps:

- 40 grams of TKP is added in 500 ml of water with constant mechanical stirring. The concentration of the prepared paste is maintained at 8% w/v.
- Seven samples were prepared in which one is without any preservative and the rest six with preservatives.
- The dispersion mixture is vigorously stirred for 15 minutes by laboratory mechanical stirrer running at 4000 RPM at room temperature.
- Maximum and uniform viscosity is quickly obtained on cooking the mixture in a hot water bath at 70 - 80 °C for 25-30 minutes.
- The mixture is then allowed to cool to room temperature.
- After 24 hours of stabilizing, this TKP is used for further research [1].

Measurement of Viscosity:

Instrument Details:

Make & Model: **FUNGILAB, VISCOLEAD ONE R**
Serial Code: VL101002
Viscosity Range: 100 - 130,000,000 Cp
Spindles Available: R2, R3, R4, R5, R6, R7

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Procedure followed for accurate Viscosity Measurement:

- The leveling screw is adjusted for perfect leveling until the spirit bubble is within the marker circle.
- Instrument electrical power supply is then switched on.
- System will start and the 'Home Page' is displayed on the screen.
- Instructions displayed on the home page are then systematically followed.
- Spindle is removed and 'Enter' key is pressed / selected to initialize 'Auto Test'.
- Options displayed after 'Auto Test' are:
 - 1) **Instrument Profile.**
 - 2) **Measurement.**
 - 3) **Calibration**
- Following steps were adopted for accurate Viscosity Measurement:
 - 1) 'Measurement' menu is selected and 'Enter' is pressed.
 - 2) Appropriate Spindle Number & RPM are selected.
 - 3) 'ON' key is then pressed.
 - 4) Viscosity measurement will start.
 - 5) Torque is maintained within 15 - 95 %.
 - 6) After stabilization of the display, displayed measurement is noted and the rotor/motor is stopped by again pressing the 'ON' key.
 - 7) Finally press 'QUIT' key followed by removing the test sample, carefully cleaning the instrument parts and adopting the specified switching off procedure.

III. RESULT AND DISCUSSION

Table of Viscosity Measurement:

	Blank Thickener		<i>Azadirachta indica</i>		<i>Calotropis species</i>		<i>Nerium species</i>		p-chloro m-cresol		Sodium Azide		Zinc Chloride	
	Viscosity cP		Viscosity cP		Viscosity cP		Viscosity cP		Viscosity cP		Viscosity cP		Viscosity cP	
	Torque %		Torque %		Torque %		Torque %		Torque %		Torque %		Torque %	
Day 01	18670	pH	65180	pH	1230	-	1323	pH	60320	pH	57846	pH	63513	pH
	93.00	7.3	97.8	7.5	1.9	-	2.3	6.1	58.0	7.5	87.3	7.3	95.3	7.0
Day 02	11887	pH	13936	pH	-	-	-	-	59335	pH	42833	pH	54489	pH
	58.00	6.4	20.9	6.5	-	-	-	-	56.1	7.3	64.3	7.0	81.7	6.6
Day 03	7325	pH	1120	pH	-	-	-	-	54917	pH	32700	pH	19940	pH
	39.3	4.0	1.9	3.5	-	-	-	-	84.3	7.0	49.1	6.5	26.4	6.0
Day 04	109	pH	-	-	-	-	-	-	54377	pH	28872	pH	1360	pH
	0.8	3.8	-	-	-	-	-	-	81.0	7.0	43.3	6.2	2.0	4.0
Day 05	-	-	-	-	-	-	-	-	52525	pH	24565	pH	-	-
	-	-	-	-	-	-	-	-	78.8	6.5	36.8	5.0	-	-

Viscosity is measured at 6 RPM using Spindle No. 5 at 37 °C.

From the above results it can be concluded that:

1. TKP thickener without any preservative was hydrolysed after 48-72 hours due to the growth of microorganisms.
2. Viscosity was monitored by FUNGILAB viscometer.
3. Viscosity drops due to the hydrolytic activity of bacteria in the Blank sample of TKP thickener without preservatives.
4. Natural preservatives *Azadirachta indica*, *Calotropis species*, *Nerium species* in the thickener were very less effective in curbing microbial growth, which is evident from the continuous drop in viscosity readings with the passage of time.

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5. Out of the synthetic preservatives: p-chloro m-cresol, sodium azide, Zinc chloride, only p-chloro m-cresol exhibited best results with maintenance of optimum viscosity for long time period without any significant change in pH.
6. Sodium azide showed moderate results where as Zinc chloride did not show a marked effect to maintain the viscosity.

IV. CONCLUSION

TKP thickener is used in textile industries, which is hydrolysed after 48-72 hours due to microbial growth, rendering it useless leading to considerable loss of material and man-power input. Out of all the preservatives tested, only p-chloro m-cresol gave promising results as per the above results obtained. The exact quantity of the p-chloro m-cresol can be optimized by carrying out the same procedure at different concentrations of the p-chloro m-cresol to reduce the cost of the thickener. Now it is up to individual users to determine the exact quantity of the preservative to be incorporated in the preparation of the thickener for achieving cost effective results, as physical factors like ambient temperature, water hardness and production program / schedule vary from area to area and also unit to unit in the same geographical area.

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