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Batch Production Kinetics Of Xanthan Gum From Potato Waste

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Abstract: Xanthan gum is a polysaccharide has been widely used in the pharmaceutical industry. Production of xanthan gum by a bacterium *Xanthomonas compestris* NCIM2961 was investigated from potato waste as a source of carbon. Production yield was improved by pretreatment of the potato residue with NaOH and HCl. The medium components considered are potato waste, yeast extract, peptone, $FeCl_3$, K_2HPO_4, $MgSO_4.7H_2O$, $(NH_4)_2SO_4$, Citric acid, H_3PO_3, $CaCO_3$, $ZnCl_2$, NH_4NO_3. The optimum production of 45g/l was found at 28 ˚C when bacterium culture was incubated for 96 hours. From these findings it has been concluded that potato waste can be a promising substrate for xanthan gum production.

Keywords: Xanthan gum, pretreatment, potato residue, polysaccharide, yield

I. Introduction.

Xanthan gum considered as the first biopolymer which is produced industrially. The bacterium *Xanthomonas campestris* is exploited for the production of xanthan gum, natural source of a polysaccharide. X*anthomonas campestris* which is utilized for the xanthan gum production, the growth rate is increased by 5-10% annually. The commercial production of the xanthan gum involves batch production instead of the continuous mode, having a sugar source such as glucose [20].The aerobic process for the xanthan gum produced using bacteria *Xanthomonas campestris* is carried in a semi-solid or a liquid media. The application of xanthan gum is important in an agricultural point along with many other useful branches such as industries which include many physio-mechanical requirements for products by thickening, stabilizing, gelifying, emulsifying as well as suspending age [5].

Xanthan gum structure includes a repeated units of the pentasaccharide units which helps in the formation of its heteropolysaccharide structure. xanthan gum side chain constitution consists of two units of glucose,two units of mannose and one unit of glucuronic acid in the ratio of 2.8 :2 :2 [2-4]. An anionic polysaccharide type is produced by the presence of acetic and pyruvic acid. xanthan gum viscosity is increased at moderate temperatures [23-24]. The dissolution of xanthan gum by temperature affects its viscosity by altering various factors controlling its molecular conformation and its appearance specifically of its ordered structures which have two conformations of molecules that is helix and random coil determined by the temperature of dissolution. The fermentation of bacteria *Xanthomonas campestris* is involved in the production of non-linear xanthan gum which is an anionic heteropolysaccharide [25-27].

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The highly viscous solution of the xanthan gum is acquired by a cessation at an average temperature. The gum obtained highly viscous and exhibits the pseudo-plasticity at low concentrations. The concentration is reported as having considerable effects as compare to the temperature and the pH on the rheological features of the xanthan gum[6-8].The ability to form gel has not been done by xanthan gum individually. Food industries use the synergic effects of the xanthan gum in order to increase gross viscosity as well as the gelling properties [1].

Xanthan gum molecular weight has a range between 0.9×10^6 to 1.6×10^6 Daltons (Da), which depends on a microbial source as well as the fermentation conditions[15-16]. It is estimated that the consumption of the xanthan gum is 23 million kg/year that has annual rate 5%-10%. The aqueous solution of xanthan gum has three properties:-(i) at low concentrations it exhibits high viscosity. (ii) The pseudo-plasticity (iii) Its intensity towards the temperature, pH and electrolyte concentrations.(kamal *et al.*,2003).*Xanthomonas Campestris*, a proteobacteria genus that can cause various plant diseases. *Xanthomonas* genus is a subject of several taxonomic as well as various phylogenetic studies which was initially reported as a bacterium vesicatories, in 1921 as pepper and tomato pathogen.*Xanthomonas campestris* was further reclassified by Dowsan and given as genus xanthomonas. *Xanthomonas campestris* helps in the making of the xanthan gum which is used in various fields of industrial uses such as in foods, cosmetics, and petroleum products[9-14,18-19].

Xanthan gum favours an important role in an industrial application as thickener, emulsions stabilizer and is attached to water construct drilling fluid up to its pseudoplastic behavior with thermal stability due to the high molecular weight it favors constructions of networks i.e., physical and chemical, which is utilized as drugs carriers, proteins and as cells scaffolds. Xanthan gum in union with another polymer has been used as excipient in tablets and also used to support hydrogels for drug release [17].

II. Materials & Methodology:

Raw material: Potato waste was used as a source of carbon to carry out the production process. Xanthun gum production was done by bacterial culture *Xanthomonas Campestris* (NCIM 2961) which was procured from NCBS, Pune. The experiment was carried in 500ml Erlenmeyer conical flask containing 10% (V/V) of inoculum. Production medium was incubated for 48 hours at 28 ˚C in orbital shaker at 150 rpm. Production media was prepared in (g/l): potato waste 40, yeast extract 3, peptone 5, K_2HPO_4 ,5; $MgSO_4.7H_2O$, 0.2; citric acid ,2; H_3BO_3, 0.06; $ZnCl_2$, 0.06; $CaCO_3$,0.02 with initial pH 7 [21]. Pretreatment of potato waste was carried out with acid (HCl) and base (NaOH) in 1:10 (W/V %). Sugar content of pretreated potato waste was determined by DNSA method [3]. Recovery and purification of xanthan gum: Centrifugation was carried out at 15000 rpm to remove the cell from the 48 hours of the culture. Cell-free supernatant (1.5 ml) mixed with the 3 ml solution containing 0.1% $CaCl_2$ in isopropanol, which resulted in xanthan gum precipitation. Precipitated gum was isolated by centrifugation at 15000 rpm for 45 minutes and then dried in hot air oven at 50℃ for 48 hrs.[22].

III.Result and Discussion:

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Batch culture kinetics: Weight and yield of xanthan gum were analyzed after 96 hours of incubation which shows 6.6 g/L of cell biomass and yield of xanthan gum was computed as 45g/L for the first batch production which was carried out at 28.5 ^{0}C at pH:7 and 150 rpm. The second batch production which was carried out at 26 ^{0}C at pH:7 and 110 rpm show 2.72 x 10^{-3} g/L of biomass produced and 0.178g/L of xanthan gum yield was observed. Figure 1, shows the effect of temperature on the production of xanthan gum.

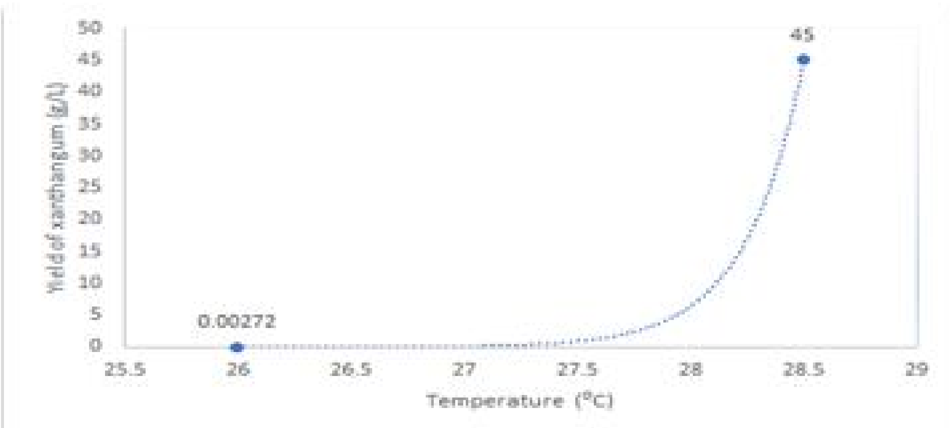

Figure1: Effect of temperature on the production of xanthan gum

FTIR analysis of xanthan gum: FTIR Analysis of laboratory-produced xanthan gum, was performed to detect the presence of functional groups in it. Mainly four groups are present in xanthan gum, which is hydroxyl group, acetal, carboxyl and carbonyl which helps in the formation of xanthan gum structure. FTIR graph has wavenumber on X-axis and the light transmittance on Y-axis. According to Kedar *et al*,FTIR spectra of commercially available xanthan gum have highest peak at 3317.34 cm^{-1}. The standard xanthan gum highest peak at 3330 cm^{-1}as shown in figure2.

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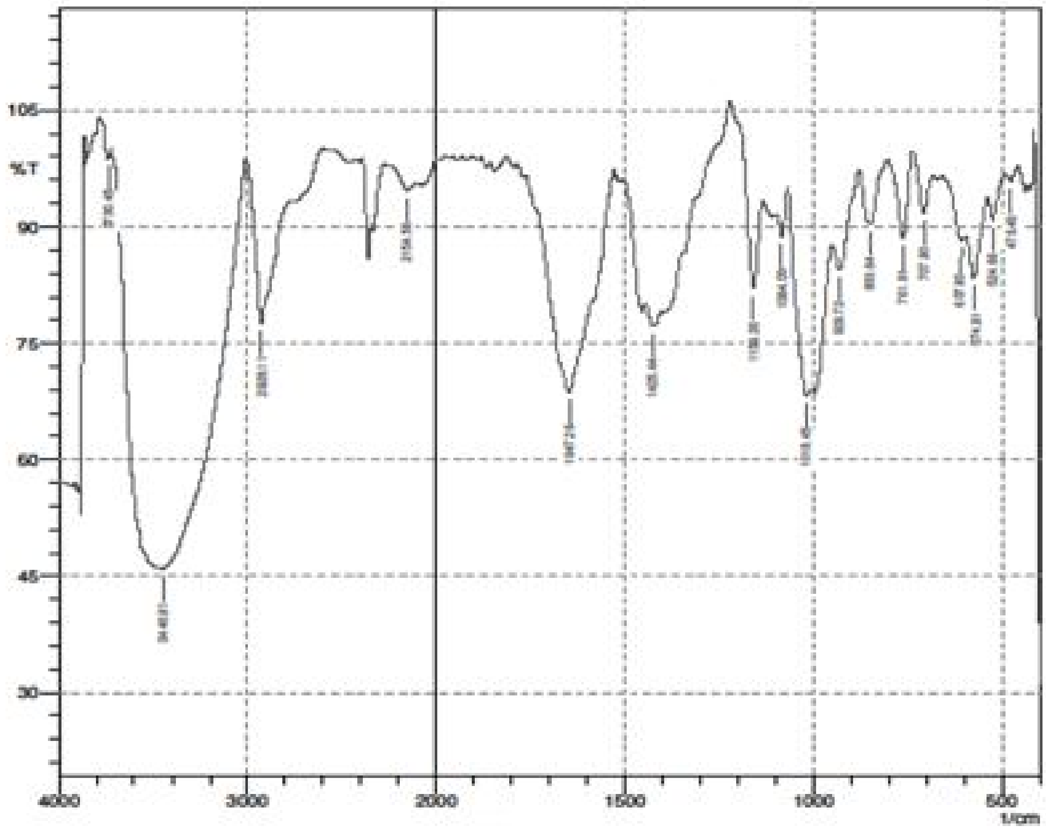

Figure2: FTIR analysis of xanthan gum

The viscosity analysis of xanthan gum: Viscosity of the xanthan gum was determined by Ostwald viscometer. 1% (W/V) of xanthan solution which was suspended in 0.1%NaCl, $CaCl_2$, KCl solutions were used for viscosity determination (Tako, *et al.*,2014). The viscosity of the xanthan gum produced was found to be 9.54 $mPa.s$ in 0.1% $CaCl_2$ solution, 6.91 $mPa.s$ in 0.1% KCl, 10.35 $mPa.s$ in 0.1% NaCl solution. techniques used.

IV. Conclusions

Production of xanthan gum by *Xanthomonas campestris* using potato as carbon source was successfully carried out and optimized at different rpm, nitrogen source and temperature for two batch production. Batch culture kinetics shows that temperature, agitation rate, pH, and medium composition will influence the production of xanthan gum. The result shows that the media composition and parameters of first batch production were most suited for xanthan gum production by *Xanthomonas campestris*.

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