STUDY OF SWELLING PROPERTIES OF BIO-PLASTICS PRODUCED FROM KITCHEN WASTE

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Abstract - Bio-plastics were synthesized from kitchen waste commonly generated in Indian households such as Pumpkin, Pea Shell, Potato, Capsicum, Ladies Finger, Cauliflower and Mix Vegetables. These kitchen waste were treated with Starch, Acetic acid, Glycerin in molar proportion. Swelling tests of these newly synthesized films of bio-plastics were carried out in water with different time intervals at 25°C. In this paper, an attempt has been made to investigate the swelling properties of the newly synthesized Bio-plastics with the help of the first order Fick's model and second order Schott's absorption kinetic equation model. Study revealed that the applied models were in good agreement with the experimental data. Results have shown that swelling increases with time.

Index Terms - Fick's Model, Schott's Absorption Kinetic Equation Model, Swelling Kinetics, Kitchen Waste.

I. INTRODUCTION

Now a days waste Disposal is one of the major problem faced by world. It includes all types plastics and its by product.We called it as plastic waste and tons of waste produced from households that is kitchen waste. We use plastic as polythene bags, plastic bottles, house hold things and packaging material etc. Large consumption of plastics is major source of non biodegradable waste and is one of environmental problem .

As per the study conducted by Central Pollution Control Board (CPCB) in 60 major cities of India in 2018, it has been observed that around 4059 Tons per day of plastic waste is generated from these cities. With extrapolation of the plastic waste generation data from 60 major cities, it is estimated that around 25,940 Tons per day of plastic waste is generated in India. Data revealed that out of total plastic waste, around 94% waste comprises of thermoplastic content, which is recyclable such as PET, LDPE, HDPE, PVC etc. and remaining 6% belongs to the family of Thermoset and other categories of plastics such as SMC, FRP, multi-layered, thermocol etc., which is non-recyclable [1].

On the other hand according to industry body FICCI, 43 per cent of India's plastics are used in packaging and are single-use plastic. Consumption has clearly outstripped India's capacity to recycle. The impact of this problem is so large on the environment that a mere enforcement of the ban on plastic bags is not going change things drastically. Another big environmental problem is house hold waste that is kitchen waste and its disposal. Every day tons of kitchen waste is produced in India through every houses restaurants and where food productions factories are set up. Wastes are thrown away on open space as dumping place on ground and very less part is recycled through composting. This leads to unbearable smell of rotten waste spread over large area of every city in India and consequently increase in rate health problems day by day. Cleanliness is big issue in every locality. Attempt has been made by group of scientists that conversion of food industrial wastes into bioplatics [2]. Similarly some scientists are working on composting prepared from biodegradable waste [3]. But more research required towards bio-plastic from household waste. Sustainable remedy for both of these problems is to produced Bio-Plastics from waste so that we can give contribution to clean and disease free India.

So, attempt has been made to produce biodegradable plastic from kitchen waste so that proper utilization can be boon for new step in Bio-plastic production, reduce environmental pollution and also reduction in rate health hazards .This is one important step to shining India.
In present study bio-plastics are prepared from kitchen waste by using starch, acetic acid and glycerin with molar proportions in aqueous medium. Swelling absorption kinetics models such as Fick's and Schott's model are applied to study the behaviour of water absorption with time intervals [4-5]. Swelling equilibrium depends on network structure, degree of cross linkage and hydrophilic nature of newly synthesized bio-plastics.

II. EXPERIMENTAL

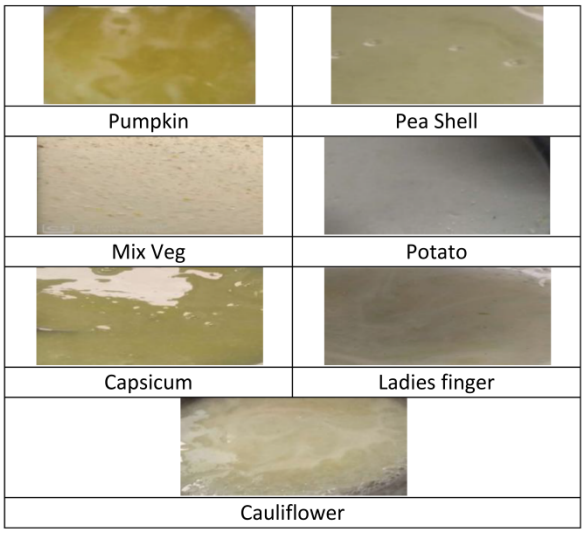
Synthesis of bio-plastics made from kitchen waste
First we collected and segregated the kitchen waste in form of its shell or waste part of each vegetable which was not used as cooking material and that was always thrown away. Then it was grounded, sieved and cooked properly with 50 mg starch, 5ml acetic acid, 5ml glycerin and 50ml of water till it became translucent and acquired desire thickness. It was then poured in plate with uniform thickness and dried. Thin

films of all bio-plastics were formed without any deformities and cracks. Molar proportions are shown in Table 1.

Table 1:- Synthesis Data of Biodegradable Plastic made from kitchen Waste

Name of Kitchen waste	Starch (mg)	Acetic acid (ml)	Glycerin (ml)	Water (ml)
Pumpkin	50	5	5	50
Pea Shell	50	5	5	50
Mix Veg	50	5	5	50
Potato	50	5	5	50
Capsicum	50	5	5	50
Ladies finger	50	5	5	50
Cauliflower	50	5	5	50

Thin films of newly synthesized Biodegradable Plastics



III. RESULTS AND DISCUSSIONS

Study of Water Swelling properties

One of its important test that is Swelling test was carried out in water as medium for experiment. Study was performed by measuring weights at time intervals of 10 minutes starting from 0 minutes to 120 minutes.

Swelling kinetic study were carried out by immersing a known amount of the dried bio-plastic with 50 ml of water in a constant temperature. Gravimetric analysis method was used to measure the swelling rate of the bio-plastics. The percent swelling rate water absorption amount was calculated using formula

$$\text{Percent Swelling Rate} = \frac{W_t - W_0}{W_0} \times 100$$

where Wt is weight of bio-plastic at time t, W_0 is the initial weight. Bio-plastic swells when it is brought into contact with water. Swelling of the bio-plastic continues until the forces due to swelling of the bio-plastic balances the pressure of the water into the swollen bio-plastic.

The swelling process involves these steps: (i) The diffusion of water molecules into the bio-plastic (ii) The relaxation of hydrated bio-plastic chains (iii) The expansion of the bio-plastic network into the surrounding aqueous solution[6].

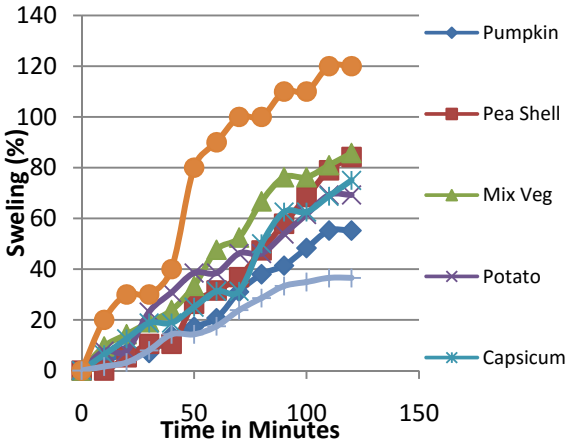


Fig 1:- Percent swelling in newly synthesized bio-plastics

From the fig 1, it is seen that initially swelling rate is constant. This may be because of filling of void space in matrix of bio-plastic then Swelling rate increases with time until equilibrium is reached.

Study of Swelling kinetics

To describe the swelling kinetics of different bio-plastics, two empirical models, namely, Fick's first-order and Schott's second-order absorption kinetic model, were used. The Fick model was used to interpret the mechanism for the first swelling time. According to first-order kinetics, the rate of swelling at any given time (t) is directly proportional to the uptake of swelling medium that has yet to occur before the maximum or equilibrium uptake (Wmax) has been reached. If Wt is the uptake at time t, Wmax − Wt is the unrealized uptake of swelling medium. If k is the proportionality constant between the rate of swelling and the unrealized swelling capacity, then

$$\frac{dW}{dt} = k(W_{max} - w_t)$$

To test the Fick's kinetics models described above, Wt - W_0 versus t graph (Fig 2) was plotted for bio-plastic. The Schott model was applied for latter data to determine the second-order kinetics correlations. The Schott's second-order equation for swelling is [7] :

$$\frac{dW}{dt} = k_2(W_{max} - w_t)^2$$

where Wmax is the maximum equilibrium water swelling, Wt is the water swelling at time t, k_2 is the swelling rate constant, respectively. After definite integration between the limits W = 0 at t = 0 and W = Wt at t and rearrangement, equation can be rewritten as follows:

$$\frac{t}{W_t} = \frac{1}{W_{max}^2 k_2} + \frac{1}{W_{max}} t$$

To test the Schott's kinetics models described above, t/Wt versus t graph (Fig 3) was plotted for bio-plastics.

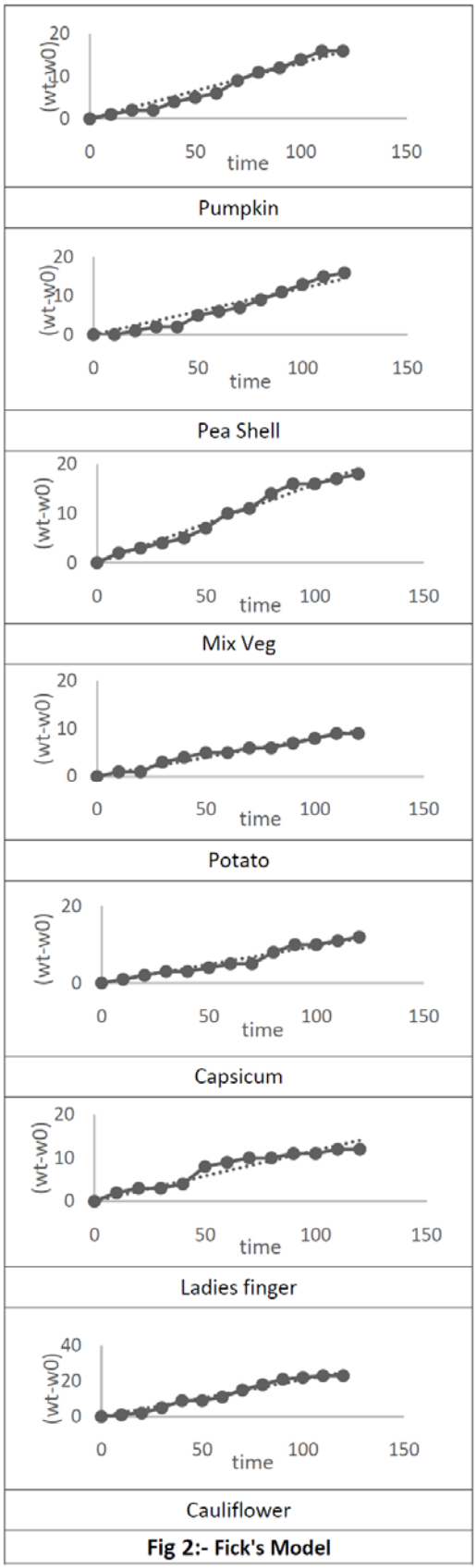


Fig 2:- Fick's Model

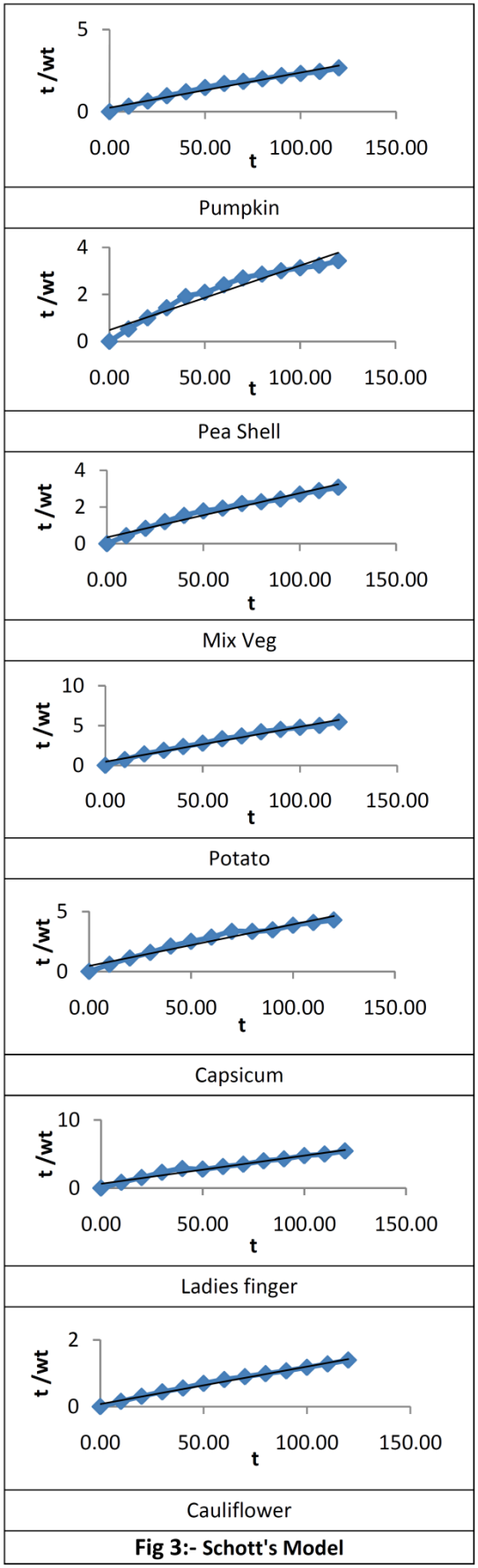


Fig 3:- Schott's Model

Values which were calculated from the slope and the intersection of lines are presented in Table 2

Table 2: Summary of Swelling Kinetics for the Bio-Plastic

Name of temple waste	Fick's First Order Model		Schott's Second Order Model	
	K	R^2	K	R^2
Pumpkin	0.01959	0.961	0.157175	0.974
Pea Shell	0.023243	0.934	0.209978	0.941
Mix Veg	0.038881	0.979	0.391271	0.967
Potato	0.024841	0.970	0.347487	0.983
Capsicum	0.025494	0.962	0.311816	0.96
Ladies finger	0.043832	0.909	0.395951	0.967
Cauliflower	0.04248	0.972	1.552545	0.991

From above data it is observed that swelling kinetics behavior of all bio-plastics have R^2 values nearly equal to 1 is in good accordance with ficks first order kinetics and Schott's second-order diffusion kinetics [8-9].

CONCLUSIONS

In this paper bio-plastics are made from kitchen waste and swelling properties are carried out. From the above discussion, it is observed that each bio-plastic has good water absorbing power and also gives best result from kinetics models. It is another step towards bio-degradability of bio-plastics because more is the water swelling property of plastic more will be the degradation power. This will fasten the recycling process. So, by synthesizing such bio-plastic from waste may help to keep clean environment and may increase the market for bio-plastics in the future. Secondly this reduces as dumping waste on ground because it directly goes for preparation of bioplastics rather than spreading over large area on ground many day. so bioplastics prepared by these kitchen waste will definitely help in becoming path for clean, green and disease free India.

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