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DETERMINATION OF THE RADIATION DOSE REQUIRED TO OBTAIN DESIRED VISCOSITY AVERAGE MOLECULAR MASS USING COMMERCIALLY AVAILABLE CHITOSAN AND SIGNIFICATION OF THIS TECHNIQUE IN ITS APPLICATIONS

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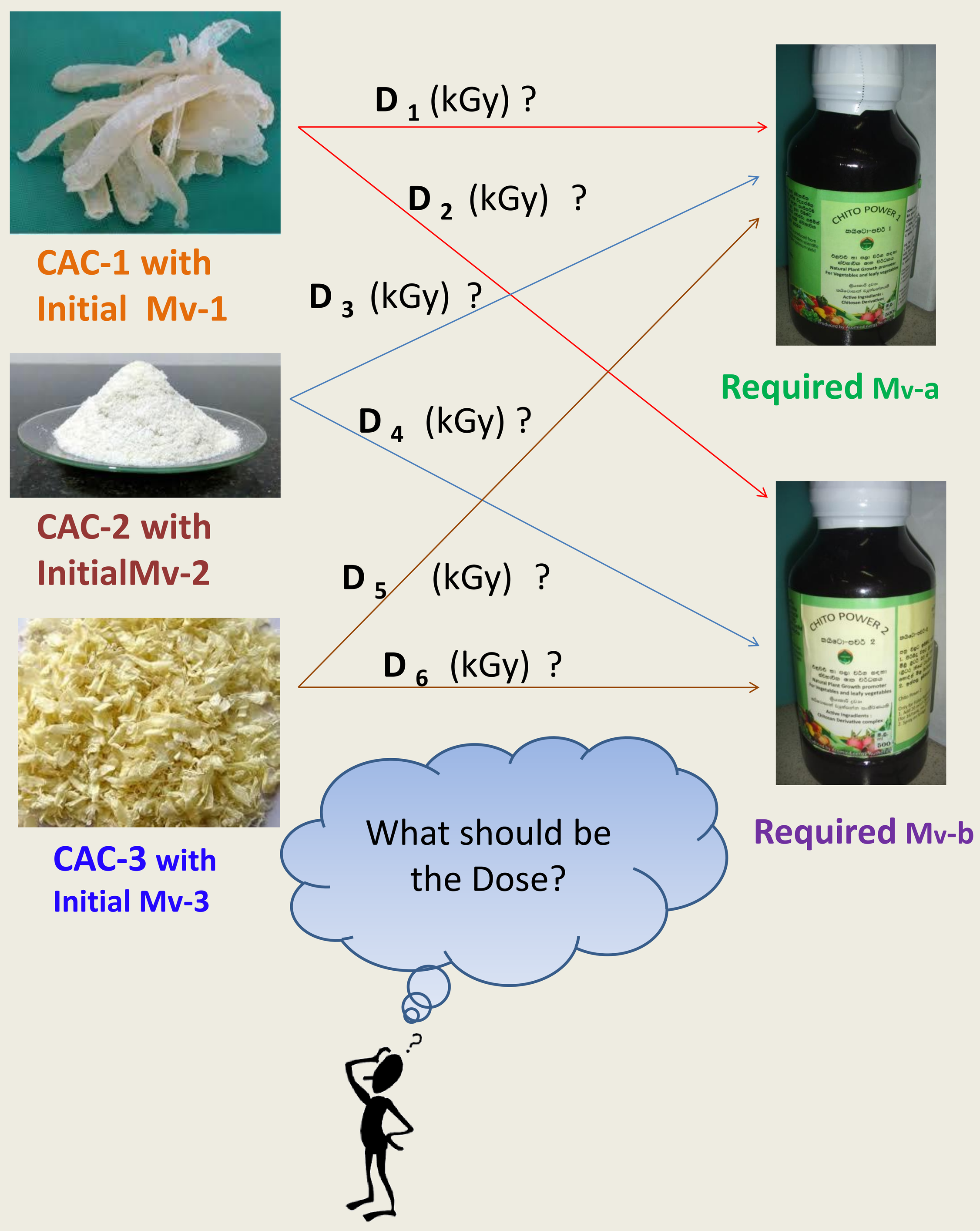
INTRODUCTION:

Radiation processed chitosan polymers are used in many applications in the field of Agriculture such as plant growth promoters, elicitors, fungicides and self-life extending coatings for fruits etc. Viscosity average molecular mass of the Chitosan is the key factor in above all applications. However, viscosity average molecular mass of Commercially Available Chitosan (CAC) show huge variations and these variations arise due to the use of different techniques in the extraction process. Determination of radiation dose required to get the desired molecular weights from a CAC with known initial molecular weight is the most important part of pilot and commercial scale production of Chitosan based agro product and development of protocol to get the desired molecular weights from a CAC by identifying required correct radiation dose essential in this matter. Therefore, the procedure developed through this study can be utilized to derive a fixed low molecular weight chitosan to follow the standard procedures used in pilot and commercial scale productions of Agro products which are based on Oligomer/Low molecular weight chitosan.

Commercial Production



METHODOLOGY:

- CAC sample (500 grams) with higher viscosity average molecular weight and known degree of deacetylation (DDA) was irradiated at different radiation doses using GC-5000 Gamma Cell under 3.4 kGy/h dose rate. 50 grams amount of 500 grams CAC sample was took out at the dose intervals 4, 8, 12, 16, 20, 24, 28, 32, 36, 40 kGy respectively.
- Each sample was used to analyzed the viscosity average molecular mass using capillary viscometric method .
- AVS 470 Visco system with a standard solvent system (0.25 M CH_3COOH/ 0.25 M CH_3COONa at 25°C) and Mark-Houwink - Sakurada equation were used for the determination of viscosity average molar masses.

RESULTS AND DISCUSSION:

$$\text{Specific Viscosity } (\eta_{sp}) = \frac{(\text{to} - \text{t})}{\text{to}}$$

Where, t = Flow time of the solution

t_0= Flow time of the solvent {sodium acetate (0.25 mol dm^{-3})/acetic acid (0.25 mol dm^{-3}) buffer solution}

$$\text{Reduced Viscosity } (\eta_r) = \left(\frac{\text{Specific Viscosity } (\eta_{sp})}{C}\right)$$

(at each Concentration)

$$\text{Intrinsic Viscosity } (\eta) = \left(\frac{\eta_{sp}}{C}\right)_{C \to 0}$$

$$\textit{Viscosity Average Molecular Weight} = \left(\frac{[\eta]}{k}\right)^{\frac{1}{\alpha}}$$

Where,

[η] = Intrinsic viscosity

k = Determined constant depend on particular polymer-solvent system ($k = 1.40 \times 10^{-4}$ dL/g for chitosan in sodium acetate (0.25 M) /acetic acid (0.25 M) at 25°C

α = Determined constant for chitosan in sodium acetate (0.25 M)/ acetic acid (0.25 M) (α=0.83) at 25°C

Relationship between the varying viscosity average molar masses vs. absorbed dose was constructed using regression analysis and desired molecular weight was obtained using this relationship.

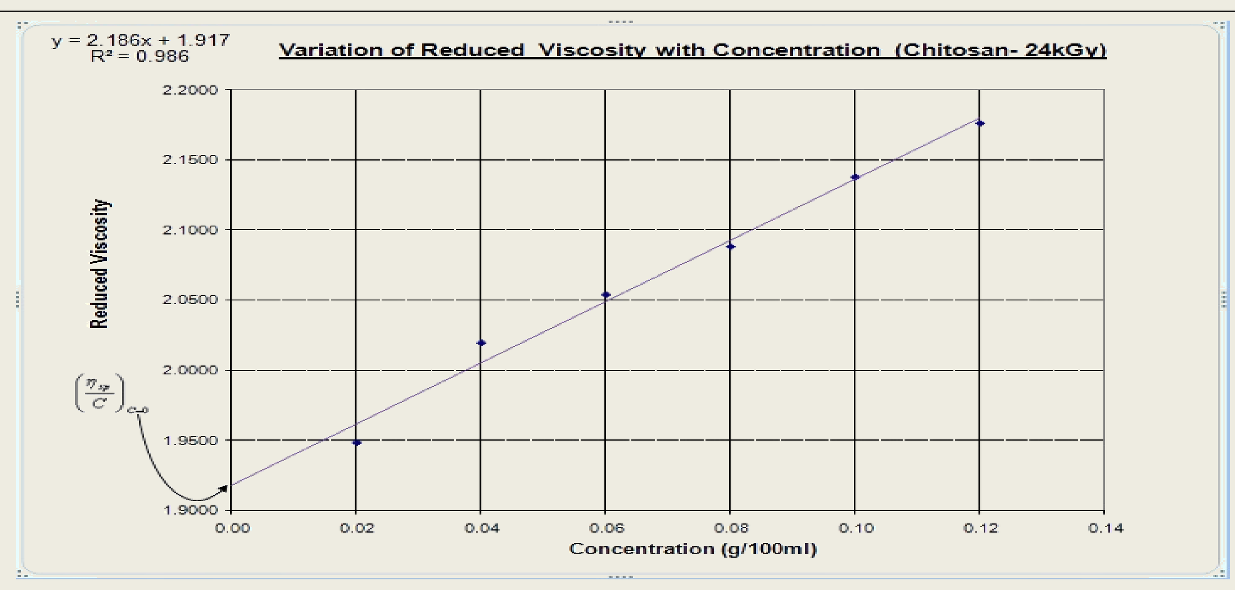


Fig-1: Determination of Viscosity Average Molecular Mass of Chitosan (Here 24kGy Irradiated CAC Selected as an example)

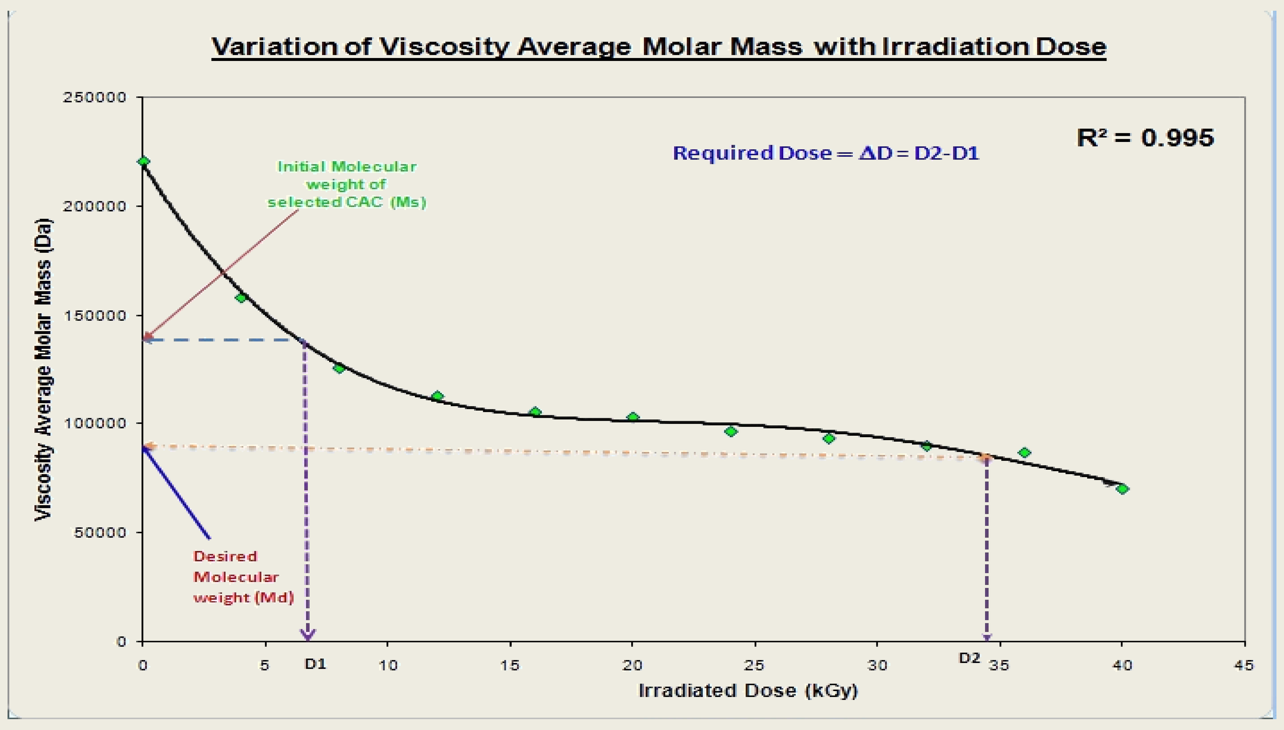


Fig-2: Construction of relation ship between the varying viscosity average molar masses vs. absorbed dose

Required irradiate dose to get the desired molecular weight can be obtained using this relationship (Fig.2).

Required Dose to get the desired molecular weight = **ΔD**

ΔD = D2 – D1

CONCLUSION:

This developed method is important and essential for the Companies which are engaged in Chitosan based production processes. Viscosity Average Molecular Mass of more than 2,000,000 Da Chitosan are also available in the market and able to update the above procedure using the above higher molecular mass Chitosan. After updating the procedure it can be introduced as a standard procedure to select the required radiation dose to get the desired Molecular mass from a CAC.

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