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Review On Study Of Impact Of Modification Of Natural Polymers On Pharmacokinetics Of Formulations And Survey Of Market Trends On Use Of Such Modifications

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ABSTRACT: Natural polymers are classified mainly into polysaccharides, polypeptides polynucleotides. They exhibit advantage of high biocompatibility,biodegradability,accessibility, stability, lack of toxicity, and have low cost. Various polymers are used inpharmaceutical formulations like tablets, capsules, creams, lotions, hydrogels and advanceddrug delivery.Scientific research articles were reviewed to check the use of various natural polymers indifferent pharmaceutical formulations. The impact of polymers on pharmacokineticproperties of formulations was identified from the scientific data. Modifications of naturalpolymers were reviewed and the impact of such modification was identified. Types ofmodifications and methods adopted for imparting the modification in natural polymers werereviewed from the scientific literature. Marketed formulations were surveyed from thepharmacies to check for label claims mentioning the name of polymer in the formula of thepolymers. The review and survey provided an outline of the natural polymers used in pharmaceuticalindustry and current position of research in natural polymers, its modifications andapplications as excipients. As per the survey though a number of companies did not disclosethe formula. It was evident from the survey data that Natural Polymers have a considerableapplication in the marketed formulations as like the synthetic polymers

KEYWORDS: Natural Polymers, Modification, Marketed formulations, Drug Delivery Systems

I. INTRODUCTION

The term polymer derived from pilus (Greek word meaning many)[1]. The term was given by Jons Jacob Bezelius in 1833. Polymers are repeating unit made up of simple monomers occurring naturally or synthetically compound. It plays necessary role in animals and plants life. Polymers exist in the form RNA and DNA in living beings. In ancient periods humanswere using this naturally occurring polymers for various purpose such as clothing,weapons, tools, shelter, decorations and many others life essentials products[2].Polymers plays important role in many dosage forms. It is basic components of controlrelease and sustained release formulations. Polymers are largely used in drug deliverydevices and formulation of drug due to their surface and bulk properties which can aiddesigning of polymers for various drug delivery application[3].In treatment of any disease, it is desire to reach the drug at specific target so the dosageforms like nano particle, microspheres, dendrimers, capsomers etc. were developed. Themechanism involved in controlled release required polymers with variety ofphysiochemical properties[4].Smart polymers are responsible to atmospheric stimulants like change in temperature, PH etc. Modification or advancement plays important role in development of many novel drug delivery system[5].The administration of drug is main challenge in Pharmaceutical and Medicinal applicationof synthetic polymers. Despite of enormous effort to develop new material in drug deliveryapplication many few of them enter in market due to hurdles of regulation, production cost efficiency and patient acceptance. Raw ingredients used to generate can get extinct and disposing of this polymer is not at all easy and it takes lot of time for this task to becompleted. If not handle with proper care it will result in environmental degradation[6].

II. CLASSIFICATION:

Classification Based on Origin:

- Natural Polymers
- Semi-Synthetic Polymers

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 Synthetic Polymers

Classification Based on Thermal Response:

 Thermoplastic Polymers

 Thermosetting Polymers

Classification Based on Application and Physical Properties:

 Rubber

 Plastic

 Fibres

Classification Based on Tacticity:

Isotactic

 Syndiotactic

 Atactic

Biodegradable Polymers:

Biodegradable polymers are extensively used in the biomedical field because of their ability of improved biodegradability and biocompatibility. The main focus is theadvancement in functionalization and responsive strategies of this polymers and theirbiomedical use. These are widely used in drug delivery as they can be degraded into non-toxic monomers[8].Significant chemical and physio-chemical differences in the individual biodegradable polymers are used for control drug delivery system.Variety of mathematical models have been created to described the physical mass transport process and chemical reactioninvolved in control drug release. The practical benefit of choosing perfect model is thateffects of device geometry and composition on drug release kinetic[9].

Evaluation of biodegradable polymers: The utmost advantage of biodegradable polymers is that the products of degradationare not toxic or are completely eliminated from the body by natural metabolic pathwayswith minimal side effects. These polymers may reduce local pH, affecting the integrity ofthe cells in their microenvironment, thus limiting their application in tissues. Polymericnanoparticles influence the pharmacokinetic behaviour of drugs. They show greatsynthesizing flexibility and hence can be manufactured in large quantity as per the requirements. The convenient characteristics of nanoparticles can be achieved bycombining different polymers. The important biomedical goal of biodegradable polymericmaterials is the development of matrices to control the release of drugs into specific sitesin the body.

Degradation-Since polymers degradation can produce alterations in a cell such as inflammatory responses, the biocompatibility of the biodegradable polymer is defined by theirdegradation products. The mechanisms of degradation for various polymers depend on thechemistry, molecular weight, and morphology of each type of polymer, and environmentalfactors such as pH or temperature also play a major role. Degradation occurspredominantly by:

 Hydrolysis

 Oxidation

 Enzymatic reactions[10]

III. PLAN OF WORK

Pre-work for planning of Survey:

• Articles were searched on various search engines such as Google Scholar.

• By referring various journals & articles which provided information on the modification of natural polymers in order to minimize the cost of polymer synthesis and change the properties of it compared to synthetic polymers.

• The aim of this survey is to provide a wide angle prospect of the different uses of pharmaceutical polymers in solid oral dosage forms. The various types of polymeric excipients are presented, and their distinctive role in oral drug delivery is emphasized.

Literature Survey:

• The collected information was categorized and reviewed as under:

• Source of Polymer

• Monomers of Polymers

• Structure of Polymers

• Application of Polymers

Survey was done on some natural polymers and their modification such as Alginate, Starch, Cellulose, Guar Gum, Pectin, Gelatin, Xanthan Gum, Gellan Gum, Chitosan, Tamarind Gum, Cashew Gum, Curdlan and this information was categorized as

Polymer

• Modification

• Modified polymer

• Formulation

• Method

• Result

Survey of Market Formulations:

Different marketed formulations were checked from different sources like local pharmacy stores and E-pharmacy. Label of this formulations were

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checked and this formation was categorized under different titles through google sheets as:

• The information to be collected were identified to be as follows:

Product
Active ingredients
Manufacturing company
Marketing company
Polymer used in that formulation
Natural polymer
Synthetic Polymer
Purpose of polymer
Type of formulation
Images of formulations

Survey on medications was done by data collection through following sources:

1. Local Pharmacies.
2. Online Pharmacies.
3. Drug information sites

• The information collected was analyzed; and survey data was represented in theindividual headings.

Data analysis: Data analysis was done using pie charts, bar graphs etc. to generate an overall statistics on the demographics.

IV. OBSERVATIONS:

Table 1. Observations for Modifications of Natural Polymers as per Literature Survey

Sr. No.	Name of Drug Formulation	Manufacturer Name	Type of Polymer as Excipient	Name of Natural Polymer (if present)	Name of Synthetic Polymer (if present)
1	Starch	urethane prepolymer grafted Corn Starch	Excipient	Graft Copolymerization	Chemical Method
2	Starch	Acylated Cassava Starch	Excipient	Acylation	Chemical Method
3	Starch	Copolymer Grafted Starch nanoparticles	Nanoparticles	Graft Copolymerization	Chemical Method
4	Starch	Succinylated cassava starch	Excipient	Polymer Modification	Radiation Method
5	Starch	Hydrophobically modified starch nanoparticles	Nanoparticles	Hydrophobic modification	Chemical Method
6	Starch	Chitosan-Starch Cross-Linked Derivatives Polymers	Excipient	Crosslinking reaction	Chemical Method
7	Starch	mucoadhesive polymer of Thai glutinous rice starch	Excipient	Ball milling	Physical Method
8	Starch	Slowly digestible sweet potato Daeyumi starch	Excipient	Enzymatic modification	Enzymatic Method
9	Starch	organic-soluble acetylated starch nanocrystals	Nanocrystals	Acylation	Physical Method
10	Starch	graft-modified starch-based nanoparticles as Pickering emulsifiers	Nanoparticles	Esterification	Physical Method
11	Starch	octenylsuccinic anhydride (OSA) - starches	Excipient	Hydrolysis	Chemical Method
12	Starch	cornstarch with glycidyl methacrylate (GMA)	Excipient	Synthetic modification	Free Radical Method
13	Starch	bionanocomposites of starch/chitosan/graphene	Nanocomposites	Polymer Modification	Physical Method

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		oxide			
14	Starch	Acylated Starch	Excipient	Esterification	Chemical Method
15	Starch	Microcrystalline cellulose–maize starch composites	Composites	Polymer Modification	Chemical Method
16	Starch	Sodium carboxymethyl high amylose starch	Excipient	Carboxymethylation	Chemical Method
17	Chitosan	Polyelectrolyte complexes of Chitosan with carboxymethyl starch	Excipient	Complexation	Chemical Method
18	Starch	Acetylated Moth Bean Starch	Excipient	Acetylation	Chemical Method
19	Starch	cross-linked gelatinized starch–xanthan gum hydrogel system	Hydrogel	Crosslinking reaction	Chemical Method
20	Starch	Cross-linked high-amylose starch (CLHAS)	Excipient	Crosslinking reaction	Chemical Method
21	Starch	Glutinous rice starch-chitosan composite films	Composite films	Ball milling	Chemical Method

Sr. No.	**Name of Drug Formulation**	**Manufacturer Name**	**Type of Polymer as Excipient**	**Name of Natural Polymer (if present)**	**Name of Synthetic Polymer (if present)**
22	Starch	Hydrophically modified Hydroxyethyl Starch	Excipient	Esterification	Chemical Method
23	Guar gum	Polyacrylamide-grafted-guar gum	Tablet	Amydation Reaction	Chemical Method
24	Guar gum	Polyacrylamide-grafted guar gum	Hydrogel	Saponification	Chemical Method
25	Guar gum	guar-g-acrylamide	Excipient	Mutual radiation grafting	Radiation Method
26	Guar gum	Hydrophobically modified guar gum Films	Films	Hydrophobic modification	Chemical Method
27	Guar gum	Enzyme-modified guar gum/xanthan gelation	Excipient	Enzymatic modification	Enzymatic Method
28	Guar gum	chitosan and guar gum based ternary blends with polyvinyl alcohol	Excipient	Polymer blending	Physical Method
29	Guar gum	guar gum benzamide	Biofilm	Benzoylation	Chemical Method
30	Guar gum	Carboxymethyl guar gum	Multiwalled carbon nanotube Hydrogel	Carboxymethylation	Chemical Method
31	Guar gum	Carboxymethyl guar gum	Microspheres	Carboxymethylation	Chemical Method

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32	Guar gum	Polyacrylamide grafted guar gum	Hydrogel microspheres	Graft Copolymerization	Free Radical Method
33	Guar gum	Guar gum/polyacrylamide graft copolymer	Nanoparticles	Graft Copolymerization	Chemical Method
34	Guar gum	methylated guar gum	Nanocomposite films	Methylation	Chemical Method
35	Guar gum	guar gum-grafted-polyacrylamidoglycolic acid	Hydrogel	Polymer Grafting	Chemical Method
36	Guar gum	Alginate–Carboxy Methyl Guar Gum	Microspheres	Polymer Modification	Chemical Method
37	Guar gum	Starch–guar gum mixtures	Excipient	Extrusion technique	Physical Method
38	Guar gum	cationic biopolymer guar gum alkylamine (GGAA)	Nanocomposites	Amination	Chemical Method
39	Guar gum	epichlorohydrin cross-linked alginate-guar gum	Matrix	Crosslinking reaction	Chemical Method
40	Guar gum	guar gum hydrolysate (GGH)	Hydrolysates	Esterification	Chemical Method
41	Guar gum	Acryloyl guar gum (AGG)	Hydrogel	Graft Copolymerization	Chemical Method
42	Guar gum	guar gum (GG) and poly(N-isopropylacrylamide)	Hydrogel	Crosslinking reaction	Chemical Method
43	Guar gum	CMGG-Ceftazidime-Collagen (ACCC)	Excipient	Graft Copolymerization	Physical Method
44	Guar gum	carboxymethylated guar gum-g-4-vinyl pyridine	Excipient	Graft Copolymerization	Chemical Method
45	Guar gum	Grafting of poly(N-vinyl caprolactam) GG	Excipient	Graft Copolymerization	Chemical Method

Sr. No.	**Name of Drug Formulation**	**Manufacturer Name**	**Type of Polymer as Excipient**	**Name of Natural Polymer (if present)**	**Name of Synthetic Polymer (if present)**
46	Guar gum	carboxymethylated guar gum-g-vinylsulfonic acid	Excipient	Graft Copolymerization	Chemical Method
47	Guar gum	hydroxypropyl guar gum (HPG)	Excipient	Graft Copolymerization	Chemical Method
48	Guar gum	-	Hydrogel	Quarternization Graft Reaction	Chemical Method
49	Guar gum	Low molecular weight polyethyleneimine conjugated guar gum	Targeting Vehicle	Conjugation	Chemical Method
50	Guar gum	Chitosan and guargum-gt-acrylamide	Microspheres	Cross-linking Method	Chemical Method
51	Guar gum	guar gum with n-butyl	Gel	Nucleophilic	Chemical Method

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		glycidyl (BGE) ether.		Substutution	
52	Chitosan	Aminated Chitosan Beads	Excipient	Amination	Chemical Method
53	Chitosan	Improved Hydrophobic Surafce Chitosan	Excipient	Hydrophobic modification	Chemical Method
54	Chitosan	Aldehyde and Acid based Chitosan Modification	Excipient	Polymer modification	Chemical Method
55	Chitosan	Deacetylated Chitosan	Excipient	Deacetylation	Chemical Method
56	Chitosan	Chitosan Conjugates	Excipient	Polymer Modification	Chemical Method
57	Chitosan	Pyridine salt grafted Chitosan	Nanoparticles	Conjugation	Physical Method
58	Chitosan	PVA+Chitosan	Excipient	Polymer Modification	Chemical Method
59	Chitosan	Grafted Chitosan	Dendrimer	Alkylation	Chemical Method
60	Chitosan	Water resistant Chitosan	Excipient	Chemica reaction	Chemical Method
61	Chitosan	tetraethylenepentamine (TEPA) modified chitosan	Excipient	Polymer modification	Chemical Method
62	Chitosan	Controlled Graft Chitosan	Excipient	Graft Copolymerization	Chemical Method
63	Chitosan	cellulose+chitosan	Excipient	Polymer modification	Physical Method
64	Chitosan	N-(Thiophene-2-acetyl)chitosan	Nanoparticles	Hydrophobic modification	Chemical Method
65	Chitosan	Hyperbranched chitosan	Excipient	Graft Copolymerization	Physical Method
66	Chitosan	Hydrophobically modified Chitosan	Excipient	Hydrophobic modification	Chemical Method
67	Chitosan	regenerated chitosan and alkyl aldehydes	Aerogels	Hydrophobic modification	Physical Method
68	Chitosan	Conjugates of chitosan and short peptide	Matrix	Polymer modification	Physical Method
69	Tamarind Gum	Carbopol 940 + Tamarind Gum	Tablet	Polymer modification	Physical Method
70	Tamarind Gum	Carboxymethylated Tamarind Gum	Excipient	Carboxymethylation	Chemical Method

Sr. No.	**Name of Drug Formulation**	**Manufacturer Name**	**Type of Polymer as Excipient**	**Name of Natural Polymer (if present)**	**Name of Synthetic Polymer (if present)**
71	Tamarind Gum	Carboxymethylated Tamarind gum	Excipient	Carboxymethylation	Chemical Method
72	Tamarind Gum	Cynoethyl+Tamarind Gum	Excipient	Cyanoethylation	Chemical Method
73	Tamarind Gum	carboxymethyl tamarind gum	Tablet	Carboxymethylation	Physical Method

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74	Tamarind Gum	Carboxymethyl tamarind gum	Hydrogel	Carboxymethylation	Chemical Method
75	Tamarind Gum	Carboxymethyl Tamarind Kernel Gum	Excipient	Carboxymethylation	Chemical Method
76	Tamarind Gum	polyacrylamide-grafted-tamarind seed gum	Suspension	Graft Copolymerization	Chemical Method
77	Tamarind Gum	sodium salt of carboxymethyl derivatives	Excipient	Polymer modification	Chemical Method
78	Tamarind Gum	carboxymethylated tamarind gum (CTG)	Microcapsule	Carboxymethylation	Physical Method
79	Tamarind Gum	1-butyl-3-methylimidazolium chloride and 1-butyl3-methylimidazolium bromide	Gel	Polymer modification	Chemical Method
80	Tamarind Gum	Gelatin-carboxymethyl tamarind gum	Hydrogel	Carboxymethylation	Chemical Method
81	Tamarind Gum	Thiolated Tamarind Gum	Excipient	Esterification	Chemical Method
82	Tamarind Gum	tamarind seed polysaccharide-blended gellan gum	Tablet	Crosslinking reaction	Chemical Method
83	Cashew Gum	Polyacrylamide Grafted Gum	Excipient	Polymer modification	Physical Modification
84	Cashew Gum	cashew gum modified with glycidyl methacrylate	Hydrogel	Copolymerization	Chemical Modification
85	Cashew Gum	modifications by introduction of new functional groups to add cationic character	Excipient	Quaternization	Chemical Method
86	Cashew Gum	Pathalte+Cashew Gum	Excipient	Pathalation	Physical Method
87	Cashew Gum	Acetylated Cashew Gum	Nanoparticles	Acetylation	Chemical Method
88	Cashew Gum	Cashew Gum + alkenyl succinic anhydride	Excipient	Hydrophobic Modification	Chemical Method
89	Cashew Gum	Acetylated Cashew Gum	Nanoparticles	Acetylation	Chemical Method
90	Cashew Gum	acetylated cashew gum	Nanoparticles	Acetylation	Chemical Method
91	Cashew Gum	Carboxymethylated cashew gum	Excipient	Carboxymethylation	Chemical Method
92	Gellan Gum	arginine-glycine-aspartic acid (RGD)	Hydrogel	Peptide modification	Chemical Method
93	Gellan Gum	methacrylated Gellan Gum (MeGG)	Hydrogel	Methacrylation	Physicochemical Method
94	Gellan Gum	GG–GRGDS hydrogel	Hydrogel	Peptide modification	Chemical Method
95	Gellan Gum	unsaturated esters of Gellan Gum	Hydrogel	Free radicle polymerization	Chemical Method

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Sr. No.	Name of Drug Formulation	Manufacturer Name	Type of Polymer as Excipient	Name of Natural Polymer (if present)	Name of Synthetic Polymer (if present)
96	Gellan Gum	carboxymethyl gellan gum	Hydrogel	carboxymethylation	Chemical Method
97	Gellan Gum	gellan gum and retrograded starch blend	Hydrogel	Cross-linking Method	Physicochemical Method
98	Gellan Gum	tyramine-modified gellan gum (Ty-GG) hydrogels	Hydrogel	Enzymatically crosslinking	Enzymatic method
99	Gellan Gum	A poly(gellan gum-co-acrylamide-co-acrylic acid)	Hydrogel	Crosslinking reaction	Chemical Method
100	Gellan Gum	GG-HA hydrogels	Hydrogel	Crosslinking reaction	Chemical Method
101	Gellan Gum	Blended Gellan gum	blends	Polymer blending	Physical method
102	Gellan Gum	methyl methacrylated Gellan gum	Hydrogel	Methyl methacrylation	Chemical Method
103	Gellan Gum	Gellan gum methacrylate	Hydrogel	Methacrylation	Chemical Method
104	Gellan Gum	polymethylmethacrylate-grafted gellan gum	Excipient	Polymer grafting	free radical polymerization
105	Gellan Gum	acetylated gellan gum gel	Hydrogel	Acetylation	ultrasonication method
106	Gellan Gum	cholesterol-modified gellan gum	Hydrogel	Grafting	Chemical Method
107	Gellan Gum	Freeze-Dried Gellan Gum Gels	Hydrogel	Freeze-Drying	Physical method
108	Gellan Gum	photocrosslinkable gelatin and gellan gum biomacromolecules	Hydrogel	Crosslinking reaction	Chemical Method
109	Gellan Gum	fenugreek galactomannan-gellan gum-calcium silicate	beads	Carboxymethylation	Chemical Method
110	Gelatin	gum arabic cross-linked gelatin scaffold	Gel	Crosslinking reaction	Chemical Method
111	Gelatin	Glycosylation fish gelatin with gum Arabic	Excipient	Polymer modification	chemical Method
112	Gelatin	carboxymethylated guar gum grafted gelatin	Films	Graft Copolymerization	chemical Method
113	Gelatin	Mechanically Biomimetic Gelatin–Gellan	Hydrogel	Crosslinking reaction	chemical Method
114	Gelatin	Gelatin Modified with Sodium Alginate	Hydrogel	Polymer modification	chemical Method
115	Gelatin	gelatin with low acyl gellan	Hydrogel	Polymer modification	chemical Method
116	Gelatin	gelatin/CMC complex	Microcapsule	electrostatic modification	Physical method
117	Gellan Gum	Modified Gellan Gum	Hydrogel	Crosslinking reaction	Physical method
118	Gelatin	Pectin and enzyme complex modified gelatin	Gel	Crosslinking reaction	Physical method
119	Gelatin	Coacervates based on	Excipient	Polymer blending	Chemical method

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		Zedo gum, cress seed gum			
120	Gelatin	fish gelatin–low-methoxyl pectin	Gel	Polymer modification	Chemical method

Table 2. Observations for Market Survey of Polymers Content of Formulations

Scrub		Pvt. Ltd.				
Stiffgon-Pro Tablet	19	Phoenix Laboratories India	Natural Polymer	Cellulose, Ethyl cellulose	-	Tablet
Hydranet Lotion	20	Palsons derma Pvt Ltd	Natural Polymer	Xanthan gum	-	Lotion
Urvija All Season Body Lotion	21	Organic Orchards Pvt. Ltd	Natural Polymer	Guar gum	-	Lotion
Neurozan Tablet	22	Meyer Organics Pvt Ltd	Natural Polymer	Sodium Starch glycolate	-	Tablet
Cognicare Tablet	23	Ceego Labs Pvt Ltd	Natural Polymer	Sodium Starch glycolate, starch	-	Tablet
Aminofit Amino Acid Supplement Soflets	24	Universal Medicare Pvt Ltd India	Natural Polymer	Maize Starch	-	Capsule
Goeuti Capsule	25	Premier nutraceuticals Pvt Ltd India	Natural Polymer	Cellulose	-	Capsule
Berbeshine Tablet	26	Maxcure nutravedics ltd India	Natural Polymer	Starch	-	Tablet
EndoRecov Capsule	27	Ambadnya Lifescience LLP India	Natural Polymer	Ethyl cellulose	-	Capsule
Celeng-Q10 Tablet	28	Innovative Healthcare,India	Natural Polymer	Sodium Starch glycolate, starch	-	Tablet
Tonecal-XT Tablet	29	Medicants Nutrients, India	Natural Polymer	Starch	-	Tablet
Fertiply-F Tablet	30	Sai Healthcare, india	Natural Polymer	Maize starch	-	Tablet
ChiroBest Tablet	31	Bajaj Nutraceuticals, India	Natural Polymer	Ethyl cellulose, Starch	-	Tablet
Digestal Capsule	32	Nouveau Medicament Pvt. Ltd ,India	Natural Polymer	Cellulose	-	Capsule
Medkal-Forte Tablet	33	Medicants Nutrients, India	Natural Polymer	Starch	-	Tablet
Filjack-Plus Tablet	34	Bio-genetica, India	Natural Polymer	Starch	-	Tablet
Cartibest Plus Tablet	35	Magnus Bio-tech Pvt Ltd, India	Natural Polymer	Maize starch	-	Tablet
Trexgen MagNext D Magnesium Glycinate & D3 Tablet	36	Trexgen Pharmaceuticals Pvt Ltd, India	Natural Polymer	Starch	-	Tablet

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Trexgen OptiThyroid Hypothyroidism Support Tablet	37 38	Trexgen Pharmaceuticals Pvt Ltd, India	Natural Polymer	Starch	-	Tablet
Cartilox Capsule	39	Universal Medicare Pvt Ltd,India	Natural Polymer	Sodium Hyaluronate	-	Capsule
40	Amicolon Capsule	Allianz Biosciences Pvt Ltd.India	Natural Polymer	Cellulose	-	Capsule
41	Antoxipan Tablet	Tirupati Lifesciences	Natural Polymer	Maize starch	-	Tablet
42	Visinerv Tablet	GH Vision Care Life Science	Natural Polymer	Starch	-	Tablet
43	GFH 10 Tablet	Manfriday Lifesciences	Natural Polymer	Starch	-	Tablet
44	Amri-Q10 Tablet	Nuorik Healthcare	Natural Polymer	Sodium Starch glycolate	-	Tablet
45	Welhib Tablet	Medicants Nutrients, India	Natural Polymer	Starch	-	Tablet
46	Duracur Tablet	RESearch MEDicine Pvt Ltd, India	Natural Polymer	Starch	-	Tablet
47	Alcofix Tablet	Alniche Life Sciences Pvt Ltd	Natural Polymer	Sodium Starch glycolate, starch	-	Tablet
48	Innovcare's New T3-LC Tablet	Sunbeam Lifesciences Pvt ltd	Natural Polymer	Sodium Starch glycolate	-	Tablet
49	Caleat -TH Tablet	Symbiosis Pharmaceuticals Pvt Ltd	Natural Polymer	Starch	-	Tablet
50	Qumed	Medsea Healthcare Pvt Ltd	Natural Polymer	Maize starch	-	Tablet
51	Viterma Capsule	Pharma Synth Formulations.Ltd,India	Natural Polymer	Starch	-	Capsule
52	Acid Soothe Capsule	Enzymedica.Inc,India	Natural Polymer	Cellulose	-	Capsule
53	Lupivestin 250mg tablet	lupin ltd	Natural Polymer	Sodium Starch glycolate	-	Tablet
54	Cobuilt Plus Tablet	Alembic Pharmaceuticals Ltd	Natural Polymer	Sodium Starch glycolate	-	Tablet
55	Health Ok	PHARMA FORCE LAB,India	Synthetic Polymers	-	Polyvinyl Pyrrolidone	Tablet
56	Supradyn	Piramal pharma Ltd	Synthetic Polymers	-	Mylobdenum	Tablet
57	WhiteTone face powder	Vini cosmetics Pvt Ltd India	Synthetic Polymers	-	Vinyl dimethicone crosspolymer	Talcum powder
58	Vaseline Cocoa glow	Hindustan Unilever Ltd India	Synthetic Polymers	-	Dimethicone	Lotion
59	Lotus herbals SPF cream	Lotus herbals Pvt Ltd India	Synthetic Polymers	-	undecylenic acid copolymer	Lotion
60	Dettol Liquid Handwash	Racking Benckiser PVT limited,India	Synthetic Polymers	-	Propylene Glycol	Handwash

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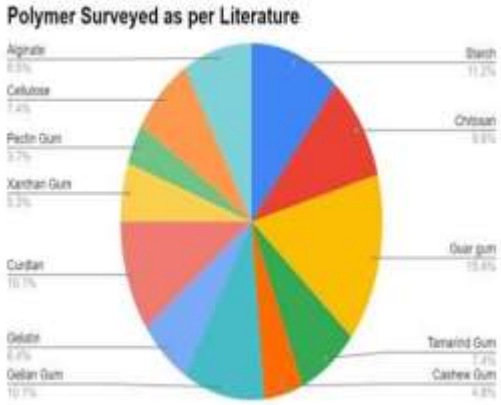
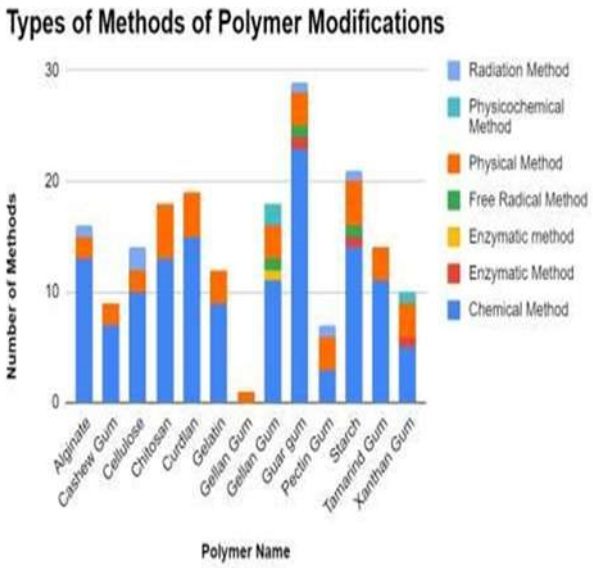
V. RESULTS AND DISCUSSION:

The Literature Survey The survey ofscientific research articles gave an extensive observation of total 188 articles and this data was analysed for the types of modification of the polymers.
The natural polymers and the number of research articles reviewed is



Given in figure.

The graph showing type of polymer modification employed for the 12 different Natural Polymers is given in Figure 2.



During survey, the information reviewed to find the formulation, if any under study during the modification experiments. The formulation under study was represented in form of pie chart as per Figure 3.

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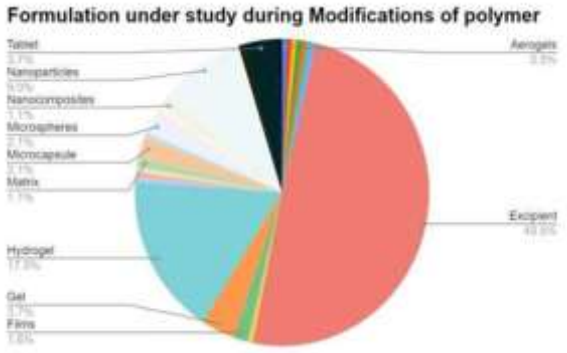
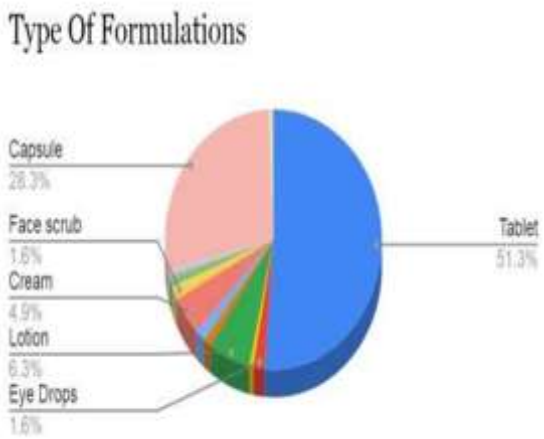
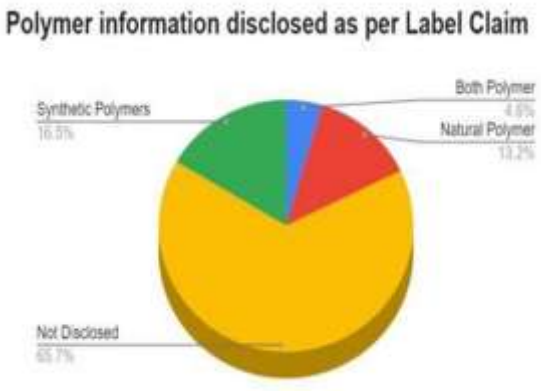


The Market Survey:

Pharmaceutical formulations were surveyed from physical pharmacies as well as e-pharmacies. We found out that out of which 51.3% were tablets, 28.3% were capsules, 1.6% were face scrubs, 4.9% were creams, 6.3% were lotions, 1.6% were eye drops. The plot of these observations of the survey have been provided in Figure 4.



Furthermore, it was observed that some of the pharmaceutical products hadn't disclosed the polymers used in the formulations due to their own company policies i.e 65.8% of the products from our survey hadn't disclosed their labels, whereas 13.2% showed Natural polymers, 16.4% showed Synthetic polymers and 4.6% showed the presence of both the polymers. The plot of these observations of the survey have been provided in Figure 5.



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VI. CONCLUSIONS:

According to the literature survey performed, it can be precluded that the natural polymers are widely applicable in advanced drug delivery systems and a number of modifications are researched upon to get better alternatives as an excipient in drug delivery systems. Natural polymers are widely used as an alternative to overcome difficulties of synthetic polymers. For modification-proper modification group along with its proper method serves as necessary tool.

Modified Polymers have improved physical and chemical properties than original one which serves as better alternative for existing and upcoming new drug delivery systems. From a market survey we can conclude that polymers and modified polymers are widely used in various commercial formulations but many products only display names of active present in the formulation. ingredientsAlthough it is also evident that many market formulations does not disclose the name of excipients.

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