A PHARMACEUTICAL STUDY OF PECTIN

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A Thesis Submitted for the Degree of

BACHELOR OF SCIENCE

(Pharmacy)

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Introduction

Due to the interest which was aroused in Pectin by the work of Fantus and Dyniewicz on Pectin Pastes and their advocating that these pastes and Pectin itself be included in the Seventh Edition of the National Formulary, a Pharmaceutical Study of Pectin was thought to be of value.

The laboratory work dealt with the use of Pectin as a substitute for Glycerinated Gelatin as a suppository base and the preparation of sterile solutions for parenteral use.

Experimental Work on Suppositories

Pectin solutions do not possess the property of having a greater viscosity when cold than when hot, similar to that possessed by glycerinated gelatin. The absence of this desireable property is the main reason that aqueous and glyceryl-aqueous solutions of pectin can not be used as a satisfactory suppository base.

Pectin when added to water must be stirred immediately to prevent formation of a gelatinous mass upon the bottom of the vessel which can not be broken up or dissolved without lengthy stirring. Use of heat is of some aid in dissolving the gelatinous mass.

Experiments were carried out to determine the proper percentage of pectin necessary to make a suppository mass of sufficient stiffness to stand handling and packing. A 10% concentration of pectin in water was finally determined by experimentation to reach the desired consistency. At this 10% concentration the formation of a gel was so fast that pouring was not possible. To avoid this quick solution glycerin was added to act as a dispersing and coating agent and incidentally to also increase viscosity. The use of equal proportions and glycerin and water with only 5% rather than 10% produced a gel so heavy and grainy that it was of no value. Evidence existed of more pectin present than water could account for. This dehydrating action of pectin is made use of in

powdering fresh yeast and tablet making where 5 to 10% pectin is added to the moist mixture to take up water and also to act as a mucilaginous binder.[1] By decreasing the glycerin content to 30% of total weight a workable mass was obtained and used in all the following experiments.

The glycerin is weighed out into a suitable container and the 5% of pectin added and stirred to disperse. No solubility of pectin in glycerin as evidenced by swelling of particles was noted at any time. Immediately after suspension of the pectin granules in glycerine distilled water was added and the solution stirred quickly until thickening was noted. Attempts to pour into the standard vaginal suppository molds met with varied results. Pouring too soon produced suppositories that were liquid at the tip and rubbery at the base because of unequal pectin distribution. Pouring at a time when the mass had been allowed more time for hydration resulted in not filling the tip of the mold because the viscosity of the solution was too great to allow the air thus trapped to escape. Smaller amounts of pectin produced semi-liquid suppositories and smaller bubbles. Attempts to heat and then pour were of no value as the viscosity did not lessen and in fact probably was increased due to faster solution of

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1 Peyer and Imhof, Deutch. Apoth. Ztg., 1928.

the pectin.

The addition of various medicinal agents was experimented with to search for incompatibilities with either the pectin or glycerin. Methylene Blue, U. S. P., had no effect on the viscosity or pouring properties of the pectin solution. The use of Tannic Acid (10%) produced lumping which could not be gotten rid of with prolonged stirring. Conclusion is an incompatibility. Use of Glycerite of Tannic Acid did not produce lumping but suppositories were semi-liquid. Chloral Hydrate, 2 Gm. per suppository as a test for production of softness in a 10 Gm. suppository had no effect. Mercurochome dissolved in the water to make 2% of the total weight produced a slightly softer suppository which had a tendency to stock to the mold. Lunargen in 10% concentration produced lumping before pouring which could not be gotten rid of. There are enough silver ions present to form a heavy metal salt of the pectin acids which are not water soluble. Metallic ions in too great concentrations must not be present in pectin solutions unless they are present in water soluble compound which can not react with pectin acids.

Parenteral Uses of Colloidal Solutions

Acacia in a concentration of 6% in normal saline has a viscosity approaching that of the whole blood and was introduced during the World War by the British to replace lost blood. Experiments by Andersch and Gibson in 1934[1] showed that the acacia introduced parenterally disappeared from the blood in two or three days and 50% of it appeared in the liver with evidence of damage as colloids have been shown to block the reticulo-endothelial system. Secondary deposits were found in the spleen, muscles and kidney.[2] Pectin and acacia are related in that both are hydrophilic colloids of a complex carbohydrate nature which yield uronic acids upon hydrolysis. It was hoped that pectin might be of a nature that would not have the adverse results exhibited by acacia solutions.

Pectin in a concentration of 1% in normal saline was immediately seen to be too viscial and a 0.5% solution adopted for use. Pectin is known to be acid in nature as shown by salt formation and precipitation with alkaline hydroxides and some metal salts. A 0.5% concentration in normal saline has a H_p of 4.25 which must be brought down near to neutrality, but not on the alkaline side, to avoid shock upon intravenous injection. Pectin solutions have been known to be stable in acid but

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1 Andersch and Gibson; J. Pharmacol, 1934.
2 Jackson and Frayser; J. Pharmacol, 1939.

readily hydrolyze in alkaline solution.

Experimentation has shown the following results using N/100 NaoH as a means of attaining a $_{p}H$ near 7.

cc. of N/100 NaoH solution added to 100 cc of ½% Pectin solution	Resulting $_{p}H$
0	4.25
20	5.9
30	7.2
50	8.9
100	10.0
500	gelatinization
1000	gelatinization

Fresh ½% solution has a natural $_{p}H$ of 4.25

Autoclaved solution . . . . .7 days old has $_{p}H$ 3.7
Non autoclaved solution . . .7 days old has $_{p}H$ 4.00
Autoclaved solution.. . . . 14 days old has $_{p}H$ 3.70
Non autoclaved solution . . 14 days old has $_{p}H$ 3.6

Conclusion: Autoclaving has little effect on a pectin solution which is normally acid.

Autoclaving ½% solution after adding 30cc N/100 Na oH yields. . . . . $_{p}H$ 4.25
Auto claving ½% solution before adding 30cc N/100 Na oH yields. . . . . $_{p}H$ 7.3

Conclusion: Autoclaving with Na O H present leads to hydrolysis and liberation of enough pectin acids to neutralize the added Na O H solution.

The solutions that were autoclaved were sterile after 14 days standing and showed no pH change. Non autoclaved

solutions had bacterial growth and showed pH change in the lapsed 14 days. Presence of Na O H was not inhibitory to bacterial growth as shown by inspection of the solutions.

Pharmaceutical Uses of Pectin

Pectin because of its similarity to acacia was recognized as an emulsifying agent as early as 1927. It was used commercially to emulsify a mint flavored cod liver oil and results in a snow-white emulsion, as do emulsions of mineral oil and castor oil. By use in fountain syrups a thicker preparation holding the fruits in suspension is produced.[1]

Uses of a more professional nature soon followed in which the great affinity of pectin for water was made use of. By use of 1% Pectin in a petrolatum base up to 50% of an aqueous solution like Liquor Alumini Acetatis or 40% of an alcoholic solution like Liquor Picis Carbonis.[2]

The emulsions made by Dr. Rapp[3] were of an oil in water type, of which the following are examples:

1.	Vasel. alb. (white Petrolatum)	20.0 Gm.
	Pektine (Pectin)	2.0 Gm.
	Wasser (Distilled Water) up to	20.0 Gm. more
2.	Liq. Paraff. (Liq. Petrolatum)	20.0 Gm.
	Pektine (Pectin)	2.0 Gm.
	Wasser (Distilled Water)	9.0 Gm.
3.	Benzol (Benzene)	20.0 Gm.
	Pektine (Pectin)	2.0 Gm.
	Wasser (Distilled Water)	40.0 Gm.

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1 Rooker; Fruit Prod. J. and Amer. Vin. Ind., 1927.
2 Peyer and Imhof; Deutch. Apoth. Ztg., 1928.
3 Rapp; Pharm. Ztg., 1929.

4.	Adeps Suillis (Lard)	20.0
	Pecktine (Pectin)	2.0
	Wasser (Distilled Water)	67.0

By adding 0.5 Gm. Pectin to 20 Gm. of the German Pharmacopoeia "Cold Cream" it is possible to add 10 Gm. more water to the formula.

5.	Weiszen Wachs (White Wax)	7.0
	Walrat (Spermaceti)	8.0
	Mandelol (Almond Oil)	60.0
	Wasser (Distilled Water)	25.0
	Rosinol (Oil of Rose)	0.1

The following aintment will allow the addition of 30% of 30% Acetic Acid or 30% of a 10% Soda Solution ($Na_2 Co_3 \cdot 10 H_2 O$) to it:

6.	Adeps Suillis (Lard)	20.0
	Pektine (Pectin)	2.0
	Wasser (Distilled Water)	35.0

By comparison with Lecithin and Cholesterol in their ability to take up aqueous solutions Pectin was found to be the most effective as shown by the following experimental data:[4]

A. 20 Gm. Lard, alone, will absorb 5 Gm. of water.
25 Gm. Lard plus 0.2Gm. Lecithin will take up 11 Gm. more
25 Gm. Lard plus 0.3 Gm. Cholesterol will take up 10 Gm. more.
25 Gm. Lard plus 1.0 Gm. Pectin will take up 25 Gm. more.

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4 Rapp; Pharm. Ztg., 1930.

B. 20 Gm. Ung. Cereum takes up 8 Gm. ofwater.
20 Gm. Ung. Cereum plus 0.2 Gm. Lecithin takes up 12 Gm. more.
20 Gm. Ung. Cereum plus 0.3 Gm. Cholesterol takes up 16 Gm. more.
20 Gm. Ung. Cereum plus 1.0 Gm. Pectin takes up 20 Gm. more.

Formula of Ung. Cereum:
Erdnuszol (Peanut Oil) 7.0 Gm.
Gelb. Wachs (Yellow Wax) 3.0 Gm.

C. 20 Gm. Ung. Lithargi takes up 20 Gm. of Water.
20 Gm. Ung. Lithargi plus 0.2 Gm. Lecithin takes up 30 Gm. more.
20 Gm. Ung. Lithargi plus 0.3 Gm. Cholesterol takes up 33 Gm. more.
20 Gm. Ung. Lithargi plus 1.0 Gm. Pectin takes up 30 Gm. more.

Formula of Ung. Lithargi D. A. B. 6
Lead Plaster 2
White Petrolatum 3
Heat on water bath until dissolved, stir until colled. Allow to stand 24 hours.

Formula of Lead Plaster D. A. B. 6
Peanut Oil 1.0 Gm.
Lard 1.0 Gm.
Litharge 1.0 Gm.
Water enough to make a plaster.

D. 20 Gm. Ung. Paraffine plus 0.2 Gm. Lecithin takes up 14 Gm. water.
20 Gm. Ung. Paraffine plus 0.3 Gm. Cholesterol takes up 20 Gm. water.
20 Gm. Ung. Paraffine plus 1.0 Gm. Pectin takes up 30 Gm. water.
In these cases the last two lose water on standing.

Formula of Ung. Paraffine D. A. B. 6
Ceresin (Paraffin) 4.0
Fluid Parafin (Liquid Petrolatum) 5.0
Water-free Lanolin (Anhydrous) 1.0
Heat ingredients on a water bath until melted and stir until cool.

E. 20 Gm. White Petrolatum plus 0.2 Gm. Lecithin takes up 5 gm. water.
20 Gm. White Petrolatum plus 0.3 Gm. Cholesterol takes up 6 Gm. water.
20 Gm. White Petrolatum plus 1.0 Gm. Pectin takes up 20 Gm. water.

Germany, because of its lack of mineral oils, has led research for substitutes for imported ointment bases. The following formulas have been developed as a type of adhesive skin paints.[5]

1. Zinc Oxide-Talc Skin Paint

Pectin	1.0
Zinc Oxide	15.0
Talc	15.0
Glycerin	15.0
Distilled water q.s	100.0

The pectin is rubbed with a little alcohol and then the water is added.

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2. Cooling Skin Paint

Pectin	4.0
Solution of ammonium Acetate	10.0
Glycerin	20.0
Distilled water q.s.	100.0

Directions as above.

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3. Cooling Skin Paint

Pectin	2.5
Alcohol	10.0
Menthol	1.0
Distilled water q. s.	100.0

Directions as above.

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4. Ichthyol Paint

Pectin	4.0
Glycerin	10.0
Ichthyol	20.0
Distilled Water q. s.	100.0

Directions as above.

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5 Haynes et. al.; Proc. Soc. Exp. Biol. andMed., 1937.

5. Tumenol Paint

Pectin	1.0
Zinc Oxide	15.0
Talc	15.0
Tumenol, ammoniated	10.0 (c_{41} H_{51} O_2 · So_3 NH_4)
Glycerin	15.0
Distilled Water q. s.	100.0

6. Sulfur Paint

Pectin	1.0
Cinnabar	2.0
Precipitated Sulfur	10.0
Zinc Oxide	15.0
Glycerin	15.0
Distilled Water q. s.	100.0

Related to these skin paints is the use of pectin pastes as surgical dressings. Pectin is naturally acid, and in solutions of $_{p}H$ 5.5 or less is bacteriocidal in that it causes a marked decrease or total disappearance of local streptococei and staphylococci on wounds.[6] Dr. George Corey was the first person to use a simple 2% flake pectin solution made adding pectin to water and dissolving by occasional shaking over 24 hours. This is followed by autoclaving at 20 lbs. for 15 min. to get rid of spores. Solution is kept sealed air-tight until ready to use. This first use was caused by unsuccessful healing of burned-skin grafts on a 10 year-old child. The pectin treatment was successful.

Pectin pastes seem to act as a filter in that it allows drainage from wounds, is non-interfering during treatment and does not kill, corrode, coagulate, injure

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6 Haynes et. al.; Proc. Soc. Exp. Biol and Med., 1937.

or wash away the living tissue of a wound or its secretions; conversely it does not allow bacteria to enter the wound. Dr. Charles A. Tompkins of the Ford Hospital in Detroit suggests that because of the large pectin molecule size it can envelope or starve bacteria. He concludes that bacteriocidal effect of pectin varies inversely with the pathogenicity of the organism. Pectin's acidity, viscosity, and hygroscopic powers are also factors in its bacteriocidal effects.

Burns are treated by changing bandages every 24 hours, rinsing the area with warm water or normal saline and covering with 3-4 layers of 2-3 inch bandages. These bandages are moistened with a 2% Pectin solution and covered with oiled silk. The bandages are remoistened every 4-6 hours. With treatment of this type there are no foul odors, purulent discharge after 24-48 hours, the gauze absorbs decomposed material and debris and rapid healing with flat surfaced bright granulation tissues. Osteomyelitis, bed sores, pressure sores, ulcers, and compound fractures may also be treated in a similar manner, but fractures and soft tissue wounds must be left open. Healing time is reduced in all cases, even where infection had set in before pectin was used.[7]

The National Formulary Revision Committee has recognized both the use of pectin pastes and the work that Dr.

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7 Thompson; Ind. Med., 1938.

Fantus has done on these pastes by suggesting their inclusion in the NF VII. Fantus worked with Pectin Grade No. 100 and advocated the following formulas:[8]

"Dense Pectin Paste"

Benzoic Acid	2.0 Gm.
Pectin (100 Citrus)	150.0 Gm.
Glycerin	150.0 cc.
Ringer's Solution q. s.	1000.0 Gm.

Dissolve the Benzoic Acid in Ringer's Solution. Mix Pectin and Glycerin in a large dry container very intimately in order that the Pectin is coated with Glycerin. Then while stirring, add the whole amount of Ringers-Benzoic Acid solution and continue stirring until homogenous.

Viscosity Flow Time Test N. L. T. 80°; N. M. T. 60° in an hour.

"Thin Pectin Paste"

Benzoic Acid	2.0 Gm.
Pectin (100 Citrus)	60.0 Gm.
Glycerin	60.0 cc.
Ringer's Solution q. s.	1000.0 Gm.

Directions as above under "Dense Pectin Paste" Viscosity Flow Time Test N. L. T. 15 seconds and N. M. T. 20 seconds.

Further work on an N. F. VII monograph for Pectin[9] was based on No. 200 grade Pectin which made changes in the formulas necessary to result in the following:

Pectin Paste

Pectin	90 Gm.
Glycerin	120 Gm.
Benzoic Acid	2 Gm.
Ringer's Solution q. s.	1000 Gm.

Dissolve the benzoic acid in 790 cc of the Ringer's Solution heated to 100° c. Mix the pectin and glycerin in a large dry container until all of the

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8 Fantus and Dyniewicz; J. Am. Pharm. Assoc., 1939.
9 Rosen; Bull. of N. F. Comm. 9, #1, p. 38, 1940.

particles of pectin are covered. Then while stirring add the whole amount of hot Ringer-Benzoic Acid Solution and continue the stirring until a homogeneous paste is formed.

Thin Pectin Paste

Pectin		35 Gm.
Glycerin		50 Gm.
Benzoic Acid		2 Gm.
Ringer's Solution	q. s.	1000 Gm.

Dissolve the benzoic acid in 915 cc. of the Ringers Solution heated to 100°C. Mix the pectin and glycerin in a large dry container until all the particles of pectin are coated. Then, while stirring, add the whole amount of the Ringer-Benzoic Acid Solution and continue the stirring until a homogeneous paste is formed.

The above two formulas are based on 200 grade pectin. If pectins of other grades are used calculations must be made accordingly. The grade of pectin is calculated on the amount of sugar 1 lb. of pectin will carry in manufacture of a jelly containing 65% sugar.[10] Care must be taken in choosing the quality of pectin as some pectins contain fermentable carbohydrates as filler tc standardize the grade.[11]

Pectin preparations of a more extemporaneous type suitable for ordinary drug store manufacture are available for cod liver oil emulsions and similar fixed oils. Bandrup[12] developed what he termed an "Emulsion Mixture":

Pectin	10
Tragant. -best	12
Gummi arab. alb. pulv. (white powdered Acacia)	16

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10 Wilson; Glass Packer, 1929.
11 Prickett; Proc. Soc. Expt. Biol. and Med., 1939.
12 Bandrup; Ph. Zenthalle, p. 421, 1934.

Gelatina alb. pulv. 1A qual. 7.8
(White powdered Gelatin)

18 Gm. of the above mixture are dissolved by trituration in 100cc. of distilled water. After standing for 30 minutes, 400cc. of boiling water are added with stirring. To this may be added 400 Gm. of Cod Liver Oil with shaking or stirring. This emulsion may be flavored or Hypophosphites added as desired.

Hypophosphites Mixture

Calcium Hypophosphite	6.0 Gm.
Sodium Hypophosphite	3.0 Gm.
Saccharin	0.2 Gm.
Water, enough to dissolve	

Flavoring Mixture

Vanillin	0.1 Gm.
Oil of Peppermint	0.2 Gm.
Benzaldehyde	0.2 Gm.
Tincture of Cinnamon	2.0 Gm.
Nipagin M.	0.5 Gm.
Alcohol, enough to dissolve	

Further experimentation with this emulsion mixture led to disappointment because of variation in qualities of the tragacanth and acacia. Removal of these and revision of the formula produced satisfactory results.[13]

Revised Emulsion Mixture

Pectin	5 Gm.
White Gelatin	5 Gm.
Saponin (from Quillaja)	1 Gm.

The pectin and gelatin are mixed as dry powders and 100 Gm. of cold water added and mixed in. To this mixture is added 400 Gm. boiling water and shake until solution results. The Saponin, previously dissolved

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13 Bandrup; Ph. Zenthalle, p. 777, 1934.

in 20 Gm. water is now added. The mixture is cooled to 50° C. and 50 Gm. of Glycerin added. The 400 Gm. of Cod Liver Oil is added in 100 Gm. portions with stirring. The flavoring and salts may now be added. If the resulting emulsion is too thick it is suggested that 3.75 Gm. of pectin be used.

Additional uses of pectin are either of a cosmetic nature or in preparations where therapeutic use is not necessarily intended. Pectin may be used with many ingredients such as silica gel, amorphous silica, titanium dioxide, alumina, purified siliceous earth, and organic and inorganic acids and salts like acetic, phosphoric, lactic, citric, tartaric acids and potassium acid tartrate which may appear in dental preparations such as tooth-pastes. Solution of hydrogen peroxide may appear with pectin but its alkaline salts like Sodium Perborate as well as C a Co_3, Mg Cog and soaps must be avoided. Enzymes seem to be compatible when not of a type furnished by bacteria.[14]

The following are two examples of tooth pastes containing pectin:

1.	Pectin	6 Gm.
	Glycerin	10 Gm.
	Water	71 Gm.
	Alcohol	10 Gm.
	Citric Acid	1 Gm.
	Condensation product of $H_2 O_2$ and urea	2 Gm.

14 Editor; Drug and Cosmetic Catalog, p. 43 c, 1935-1936.

2. Tragacanth 1 Gm.
Pectin 5 Gm.
Glycerin 30 Gm.
Water 63 Gm.

The paste is completed by adding 36 Gms. of the above mixture to:

Titanium Dioxide	37 Gm.
Pepsin	22 Gm.
Diethyl-aminodiethyloleyl-amide lactate	4 Gm.
Glycerin	4 Gm.
Volatile Oil (as flavor)	2 Gm.

Lotions and face masks and hair pomades also have been developed. In the following formulas 100 grade pectin is to be used or calculate on grade on hand accordingly.[15]

Face Mask

Mix lemon juice and pectin, paint on and allow to dry. Wash off when desired with warm water. This results in a mild astringent bleach.

Wave Set Solution

Pectin 1 Gm.
Karaya Gum 8 Gm.
Anhydrous Alcohol or Glycol 8 Gm.

Use two ounces of this mixture to a pint of hot water.

Pectin Pomades[16]

1. Pectin 1 Gm. 15 Gr.
Glycerin 4 Gm. or 1 fluidrachm
Water q. s. 100 Gm. 3 fluid ounces
Mix

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2. Pectin 1.0 15 gr.
Citric Acid 0.6 or 9 gr.
Water q. s. 100.0 3 fluid ounces
Mix

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15 de Navarre; Chemist and Druggist, 1935.
16 Goodman; Cosmetic Dermatology, p. 308, 1936.

A sunburn jelly may be made by making a jelly of suitable consistency and dissolve in it benzocaine tannate equivalent to 2% tannin.

Coagulant Properties

Pectin, as an unknown substance, has been recognized since ancient time because of some of its properties. The slavs of old Austria used to apply fresh apple peelings to wounds to aid coagulation,[1] but it was not until 1924 that Violle and Saint-Rat[2] studied the use of injections of pectin solutions followed by pectase as a means of coagulating the blood. In 1935 a commercial product called "Sango-Stop"[3] appeared on the market for oral, intramuscular or intravenous use, which was used in quantities up to 100cc of a 2.5% solution. This was a solution of apple pectin which was supplied in 20cc ampules in a $CaCl_2$ isotonic[4] solution. When used in the test tube on blood samples[5] it and the other pectin solutions are of no value, while used in vivo the time for coagulation is reduced 40 to 50%. When used orally it takes about 3 hours to show effects but intravenously the effect can be noted immediately.[6]

For other than wound uses this solution has been suggested for tubercular lung hemorrhages; cirrhosis, atrophy, and hypertrophy of the liver.[7]

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1 Gohrbandt; Deutch. Med. Wachschi., 1936.
2 Violle and St.-Rat; Compt. rend., 1925.
3 Klarenbeek; Nederland. Tijdschr. Geneeskunde, 1935.
4 Rojahn; Arch. Pharm. 1936.
5 Rieses; Klin Wachschr., 1935.
6 Klarenbeek; op. cit.
7 Sack; Klin. Wachschr., 1935.

Pectin in Diarrhea and Constipation

Raw apples and their peelings have been used for diarrhea and also conversely for constipation as well as for dyspepsia, both chronic and acute, colic and typhus.[1] In its styptic action on diarrheas it works in a manner similar to the tannate preparation "Tannalbin".[2] As a detoxication mechanism it is conjugated with the poisons present causing the irritation leading to the state of diarrhea.[3] By addition of certain heavy metal salts the pectin can be made to be antiseptic as well,[4] especially useful in amoebic dysentery. By experiment these compounds have been shown to be non-toxic and non-irritating. On B. coli stock solutions in test tubes the pectinates of Ni, Co, Mn, Pb, Zn, Cu, Ca, and Ag were active. The Ag compound was found to be the most active on B. coli, B. typhose and Staph. alb., while the Cu compound was most effective on Staph. aureus.[5]

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1 Moro; Klin. Wachschr., 1929.
2 Gebhardt; Klin. Wachschr, 1935.
3 Manville; Am. J. Digest. Diseases and Nutrition, 1936.
4 Block, et. al.; Am. J. Digest. Diseases and Nutrition, 1939.
5 Arnold; Am. J. Digest. Diseases and Nutrition, 1939.

Sources of Pectin

Pectin is a very important plant cell constituent, being second only to cellulose in quantity present and found in all plant parts.[1] Fruit peelings may be up to 50% pectin and generally are used as the commercial source, particularly those of lemon, orange and apple.[2] Braconnot is given the credit for discovering and naming pectin in 1824, using the Greek term πηκτός , meaning "curdled" or "congealed." Upon hydrolysis it yields polygalacturonic acids, l-arabinose, d-galactose, methyl alcohol and acetic acid.[3] Due to the active carbonyl groups present commercial pectins are not uniform. The presence of Na, Ng, Ca ions and $As_2 O_3$ are reported due to fruit spraying.[4] Older plant tissues do not have as much pectin due to polymerization to lignins. The amount of cellulose present in the tissues does not change during aging and lignification but the lignin and pentosan content rises while the pectin content falls. It is concluded that pectins change to lignins and to a smaller extent to peutosans.[5]

The actual structure of pectin is not known but the equivalent weight of Pectic acid is 229 as determined by its sodium salt and Pectinic Acids is 603. Pectinic

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1 Sauer and Sanzenbacher; Kolloid Z., 1937.
2 Reichert; Deutch Apoth. Ztg., 1937.
3 Schneider; Chem. Ztg., 1936.
4 Arnold; Am. J. Digest Dis. and Nutrition, 1937.
5 Meuse; Rec. trar. botan neerland, 1938 (see No. 30 under Sources).

Acid is a strongly negative colloid, being less readily precipitated from solution than Pectic Acid.[6] Pectin itself is usually precipitated from solutions by electrolysis, or strong alcohol. As pectin it is of value but as the hydrolysis produces Pectic and Pectinic Acids the value is lost as a gelling or emulsifying agent.[7]

Analyses of the following plants have shown indications of pectin:

Agar-agar (1)
Althea (1)
Angelica Root (3)
Apples (11), (18), (37)
Aralia (1)
Ascelepias (1)
Avocado Leaf (16)
Banana peel (5)
Bean pods (13)
Beet pulp (34)
Bergamot (7)
Bignay (10)
Cacao (Cocoa) products (33)
Calumba (1)
Cascarilla (1)
Cassia Fistula (1)
Celery (stalks) (21)

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6 Bonnes, Proc. Acad. Sci. Amsterdam, 1935.
7 Back, Pharm. J., 1931.

Chondrus (1)

Citrus Fruits (4)

Clover (11)

Coir Fiber (17)

Colocynth (1)

Cotton Fiber (40)

Cranberries (15)

Cucumbers (26)

Currants (11)

(Dandelion Root) Taroxacum (1)

Digitalis (1)

Duhat (10)

Euonymus (1)

Flax (24)

Gentian (1)

Geraneum (1)

Gooseberries (11), (18).

Grapes (11), (6)

Grapefruit bark (23)

Grapefruit (Rind) (12)

Grasses (11)

Guava (4), (10)

Hevi (10)

Hops (1), (27)

Kendir (Apocynum venetum) (20)

Lactucarium (1)

Lemon Bark (23)

Lemon (Rind) (9)

Loquats (4)

Mabolo (10)

Mallow Leaves (1)

Monocotyledons (30)

Musk melons (19)

Myrobalans (25)

Naranjita (10)

Opium (1)

Oranges (9)

Paper Pulp (41)

Peaches (2), (32)

Peanuts (28), (37)

Pears (32), (35)

Philippine Oranges (10)

Pickles (26)

Pine bark (8)

Potatoes (11)

Prunes (1)

Quassia (1)

Quercus (Oak bark) (1)

Ramie Bast (14)

Raspberries (11), (18)

Red birch bark (8)

Rhamnus Cathartica (1)

Roselle (4)

Santol (10)

Sarsaparilla (1)

Sclerenchyma Fibers (30)

Seville Oranges (18)

Spruce bark (8)

Straw (11)

Strawberries (11), (18)

Sugar Beets (22)

Sweet Limes (*citrus limeta*) (9)

Sweet pea pods (13)

Tahiti Limes (10)

Tamarind (1)

Taraxacum (Dandelion Root) (1)

Tea leaves (39)

Tobacco leaf (38)

Tomatoes (29)

Tragacanth (1)

Victoria plums (18)

Walnut hulls (36)

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Watermelons (19)

White oak bark (Quercus) (1)

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Chemical Investigations of the Pectin of Ramie Bast.
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Changes in Pectin of Fruits During Cold Storage.

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Soluble Pectin Changes in Gas-stored Fruit.

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The Effect of Ethylene on Pectic Changes in Ripening Fruits.

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Rooker, Wm. A. 1927

New Uses of Fruit Pectin.

Fruit Prod. J. and Amer. Vinegar Ind. 7, #1, p. 11-13; (Chem. Abs., 22, 286).

Pectin as an emulsifying agent of essential oils, castor oil mineral oil, salad dressings and tree spray emulsions. Suggestions of use as mucilage, in confections and as an agglutinant of blood.

Daughters, Milo R. 1928

Fruit Pectin--Its Commercial Manufacture and Uses.

Avi Publishing Co.

Manufacture of pectin on a commercial scale described. Use as emulsifier for oils, thickener of syrups and foam producer in carbonated beverages suggested.

Peyer, W. and Imhof., W. 1928

Uber Pektine.

Deutch. Apoth. Ztg., 43, #41, p. 613.

Methods of extraction. Formula of an ointment containing 50% aqueous or 40% alcoholic medicament. Method for powdering fresh yeast. Use as a drying agent in tablet manufacture.

Moro, E. 1929

Zwei Tage Apfeldiat (Roh und Grieben) Zui Behandlung Diarrhoischer Zustande im Kindesalter.

Klin. Wochschr., 8, p. 2414

Use of apple, for its pectin content, in treating children from 1 to 5 years of age suffering from chronic dyspepsia, acute dyspepsia, typhus and colic.

Rapp, Dr. 1929

Emulsionen und Emulsionssalben.

Pharm. Ztg., 74, p. 1497-9; (Chem. Abs., 24, 2237)

Use of pectin in making pastes and creams containing water or acid solutions.

Wilson, C. P. 1929

Different Forms of Pectins and How to Handle Them in Manufacturing.

Glass Packer, 2, p. 113-14; (Chem. Abs. 23, 2508).

Standardization of pectin: Amount of sugar that one pound of citrus pectin will carry in the manufacture of a jelly containing 65% sugar.

Rapp, Dr. 1930

Emulsionssalben.

Pharm. Ztg., 75, p. 303

A comparison between Lecithin, Cholesterin and Pectin in their ability to take up water in ointments.

Back, S. 1931

Pectin in Jams and Jellies.

Pharm. J., 127, p. 44; (Chem. Abs. 26, 1358).

Heating of pectin over long period yields upon hydrolysis pectic and pectinic acids which are of no value.

Pectin estimated by precipitating with alcohol, hydrolysis with weak alkali and separating as the insoluble calcium pectate.

Pectin may be separated from electrolytes by dialysis.

Katalkherman, A. 1933

Pectin andCasein in Pharmaceutical Preparations.

Khim. Farm. Prom., 2, p. 68-72, (Chem. Abst., 27, 4878)

Pectin has the greatest viscosity in 10%

solution of pectin, casein and acacia solutions.

Kozhevenno, D. Grafor 1933

Utilizing the Acid-free Pectins in the Preparation of Imitation Leather.

Obuonaya Pron., 12, p. 321-2; (Chem. Abs., 29, 1091)

Use of pectin as a glue substitute in making artificial leather. Pectin can not be used as a total substitute but may replace 40% of flesh-side glue.

Andersch, Marie and Gibson, R. B. 1934

Studies on the Effects of Intravenous Injections of Colloids.

J. Pharmacol., 52, p. 390-407; (Chem. Abs., 29, 1517)

Intravenous injections of acacia solutions into rabbits and dogs led to large deposits in the liver. Slow removal from liver with marked damage. Acacia quickly removed from blood by liver and stored there. Secondary deposits in spleen, muscles and kidney.

Thirty one references quoted from.

Bandrup, W. 1934

Pektin als Emulgator fur Lebertranenemulsionen.

Ph. Zenthalle, 75, p. 421-3; (Chem. Abs., 28, 5598).

Properties of emulsifiers, formula for an

emulsion mixture and best $_{p}H$ of 5. for a Cod Liver Oil Emulsion suggested.

Rapp and Peyer the first ones in pharmaceutical literature to use pectin as an emulsifier.

Bandrup, W. 1934

Uber die Verwendung von Pektinstaffen in der Pharmazeutischen Praxis.

Pharm. Zenthalle, 75, p. 777; (Chem. Abs., 29, 1577)

Supplementary to previous article.

Acacia and tragacanth removed from the emulsion mixture which now is made up of 5 Gm. Pectin, 5 Gm. white Gelatin, 1 Gm. Saponin, 50 Gm. Glycerin, 420 Gm. Water and 400 Gm. Cod Liver Oil.

Bonner, James 1935

Colloidal Properties of the Pectins.

Proc. Acad. Sci. Amsterdam, 38, p. 346-54; (Chem. Abs., 29, 4239)

Equivalent weight of Pectic Acid is 229 as determined from its sodium salt. Equivalent weight of Pectinic Acid is 603.

Pectinic acid is a strongly negative colloid and is less readily precipitated by electrolytes than pectic acid.

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de Navarre, Maison G. 1935

Pectin in Medicinal and Toilette Preparations.

Chemist and Druggist, 122, p. 235; (Chem. Abs. 29, 5598)

Pectin as an emulsifying agent for essential oils, liquid and solid petrolatum. Use of tannic acid jelly for burns, nasal jells, wave set lotions, face masks and mucilages with pectin base. Pectin compatible with citric acid, glucose, sucrose, maltose, and fructose. 100 grade pectin used in these preparations.

Gebhardt, W. 1935

Vergleichende Untersuchengen uber die Styptische Wirkung von Pektine, Tannalbin und Aplona.

Klin. Wachschr., 14, p. 1459-61, (Chem. Abs., 30, 3086)

Comparitive studies on the constipating action of pectin, tannalbin and "Aplona".

Klarenbeek, Brahn B. and Langner, T. 1935

A New Drug Promoting Bloodclotting.

Nederland Tijdschr. Geneeskunde, 79, p. 4362; (Chem. Abs. 29, 8128)

Use of"Sango-Stop" to shorten clotting time in rabbits after administrating intra-muscularly, subcutaneously or orally. Up to 100 cc. of a 2.5% solution well born intravenously, this method produces immediate action which lasts

many hours.

Ivanot, F. V. and Kleibs, G. A. 1935

Zur Frage des Ersatzes von Gummi Arabicum bei der Herstellung von Emulsionen.

Cehm. Zentr. 1935, p. 3160; (Chem. Abs., 30, 5724)

Galactose and pectin are good substitutes for acacia in preparing emulsions; casein also good but does not keep.

Riesser, Otto and Nagel, Otto 1935

Uber die gerinnungsfordernde Wirkung saurer Substanzen, insbesondere des Pektins.

Arch. Expt. Path. Pharmakol, 179, p. 748-60; (Chem. Abs., 30, 3083)

Experiments with "Sango-Stop", on dogs with data on coagulation, times when given orally, intravenously and intramuscularly.

Riesser, Otto 1935

Experimentelle Untersuchungen Uber die Gerinnungsbeschleunigende Wirkung der Pektine.

Klin. Wachschr., 14, p. 958-61; (Chem. Abs., 29, 7479)

Apple pectin will decrease 40-50% the time necessary for blood to clot when given subcutaneously, intramuscularly or orally. There was no effect upon adding pectin directly to blood

in a test tube. Violle and Saint-Rat (see Violle and Saint-Rat 1925) are credited to have, in 1924, been the founders of pectin therapy in regards to blood clotting.

Sack, George 1935

Uber die Hamostyptische Wirkung der Pektine, Insbesondere bei Hamophilie.

Klin. Wachschr., 14, p. 1536-8; (chem. Abs. 30, 3087)

Use of "Sango-Stop", to decrease coagulation time when used subcutaneously, intramuscularly or orally. Time decreased 40% in man by intravenous use. Sango Stop used in tubercular lung hemorrhages, cirrhosis, atrophy and hypertrophy of the liver. Sango-Stop a 1.5% solution of apple pectin in 20cc ampules.

Van Itallie, E. I. 1935

Overzicht van Nieuwere Onderzoeking Over Pektine en Hare Toepassingen.

Pharm. Weekblad, 72, p. 2-12; p. 25-34; (Chem. Abs., 29, 1895)

General review on recent pectin investigations.

Editor 1935-36

Pectin in Dentrifices.

Drug and Cosmetic Catalong, 1935-1936, p. 43 C.

Use of pectin in tooth pastes in which it needs no preservative. Pectin incompatible with Ca CO_3, My CO_3, soaps and other alkaline substances compatible with silica gel, organic and inorganic acids and acid salts, enzymes and hydrogen peroxide. Three tooth paste formulas.

Aragona, Giovanni 1936

The Time of Coagulation of Blood After the Administration of Pectin to Rabbits.

Boll. Soc. Ital. Sper., 11, p. 434-5; (Chem. Abst., 31, 1098)

Intravenous administration of lemon pectin in a 0.5cc doses reduces coagulation time 1/3 within 30 min., orally, time is reduced 50% in 45 min., using 2cc,; subcutaneously 50% in 45 min. using 1cc.

Bergstrom, Sune 1936

Polysaccharic Sulfur Acids with Heparin Action.

Z. fur Physiol. Chem.; 238, p. 163-8; (Chem. Abs. 30, 2637)

Sulfuric esters of chitin, cellulose, pectin and starch have an intermediate action in retarding coagulation.

Feriz, H. 1936

Blood Coagulation by Means of a New Pectin Preparation.

Nederland Tijdschr. Geneeskunde, 80, I, 517-24; (Chem. Abs., 30, 4214)

Sango Stop is a pure galacturonic acid ester. It is a hemostatic locally as well as intravenous, subcutaneous and intramuscularly. Instances of bleeding of stomach, uterus, esophagus and rectum cited as treated.

Gohrbandt, Erwin 1936

Die Einwirkung der Pektine auf die Blutgerinnung.

Deutch. Med. Wachschr., 62, p. 1625-9; (Chem. Abs., 30, 8386)

Sango-Stop is reaction-less, non-poisonous, up to 100 cc. have been given. Effects noted in 10 min. and known to last 6 days at a constant before sinking.

Use of plants to stop bleeding is old. The Slavs of old Austria used to apply fresh apple peelings to wounds in order to aid coagulation.

Goodman, H. 1936

Cosmetic Dermatology.

McGraw, Hill Book Co. N. Y. C. 1936, p. 308.

Formulas of two pectin pomades.

Manville, I. A. Bradway, E. M. and Mc Minus A. S. 1936

Pectin as a Detoxication Mechanism.

Am. J. Digest. Diseases andNutrition 3, p. 570.

Experiments on rabbits fed menthol in Ringer's Solution plus an oatmeal diet. Those rabbits receiving pectin in addition to this diet excreted three times as much uronic acids conjugated with the menthol and other aromatic alcohols, ketones, phenols, acids and similar compounds.

Pectin was noted to stimulate intestinal activity.

Rojahn, C. A. 1936

Uber die neuen Arzneimittel des Jahres 1935.

Arch. Pharm., 274, p. 213;

"Sango-Stop" prepared from apple pectin by Turon (Ges. fur pharm. Produkte, Frankf. A. M.) containing a Ca Cl_2 isotonic solution. Used as a hemostatic for local and parenteral use.

Schneider, G. 1936

Die Pektinstaffe und shre Technische Bedeutung.

Chem. Ztg., 60, p. 861

Pectin titled by Braconnot, Academy of Nancy in 1824 from the Greek πηκτός meaning

curdled or congealed.

Found to be a high molecular carbohydrate located between cell wall laminations. Made up of poly galacturonic acids, l- arabinose, d-galactose, methyl alcohol and acetic acid.

Spalding, Clarence G. 1936

Pectin as a Laxative.

U. S. Patent 2,043,204 (Chem. Abst., 30, 5370)

Solid pectin plus acacia or stearic acid which inhibits dissolving or swelling of pectin in contact with secretions of mouth or other aqueous liquids.

Used to increase peristalsis.

Arnold, L. 1937

Pectin.

Am. J. Digest. Dis. and Nutrition, 4, p. 457.

General review on pectin, its discovery by Braconnot, its structure, andclassification by author as a non-utilizable carbohydrate as shown by no blood sugar rise. Antihetogenic action noted.

Pectin of market not uniform due to an active carboxyl group. Reports Na, Ca, Mg and $As_2 O_3$ due to fruit spraying.

Bandrup, Wolfgang 1937

Uber Pektinstaffe.

Pharm. Zenthalle, 78, p. 281-84; (Chem. Abs., 31, 5611)

Pectin mentioned as a substitute for agar and gelatin as a binding agent, in jellies, marmalades, milk industry.

Use of pectin to replace tragacanth in Ung. Glycerini D. A. B. 6.

Method of manufacture given, 30-50 % of fruit juices are pectin; a reversible colloid.

Bofill--Deulofeu, Juan and Schmitz, Adolf 1937

Soluble Compounds of Heavy Metals.

Patent; (Chem. Abst., 31, 8842)

Use of "pectic acid" of pectin to render certain water insoluble heavy metal salts water-soluble by formation of pectinates. The water-soluble forms are used medicinally. Excess of 1% Na OH solution used to produce water-soluble salts.

Derouaux, G. 1937

Experimental Study of Hemostatic Activity of Sango-Stop and of Adrenalone.

Compt. rend. Soc. de Biol., 124, p. 567; (Chem. Abs. 31, 4707)

Hemostatic powers of both pectin and adrenalone (methyl-aceto-pyrocatechol) are prompt and lasting. Administration is by intravenous injection.

Haynes, Edith; Tomkins, Charles A., Washburn, Grace and Winters, Matthew 1937

Bacteriocidal Action of Pectin.

Proc. Soc. Exp. Biol. and Med. 36, p. 839-40 #5 (J. A. M. A. 109, 1283)

Pectin shows bacteriocidal action at pH 5.5 or less; its activity is inhibited by alkaline or neutral solutions. A 2% solution kills E. coli in 24 hours in a heart-infusion broth. When applied to wounds a marked decrease or total disappearance of local streptococci and staphylococci was noted.

Lampitt, L. H. and Money, R. W. 1937

Pectin Gels.

J. Soc. Chem. Ind., 56, p. 290-4 T; (Chem. Abs., 32, 1162)

Method given for measuring strength of pectin gels. Settling rapid for 3 to 4 hours. Increase in strength for 75 days. Well formed gels obtained at temperatures up to 90° C. Sugar or glycerin used to form gels in 50-55%

concentrations. Glycol also used.

Langner, T. 1937

Objective and Subjective Data Obtained During Clinical Applications of Sangostop in Otovumolaryngologic Practice.

Nederl. Tijdschr. Geneeskunde, 81, p. 188-192.

"Sango-Stop" used on tonsilectomy tampons, harmless, non-anaphylactic reacting but speeds up coagulation. Compresses for external use, 5% solution; per oral 5%; intramuscular 1½%.

Mosig, Alfred 1937

Pektin als Ersatz fur auslandische Salbengrundlagen.

Pharm. Zentralhalle, 78, p. 1-2; (Chem. Abs. 31, 2350)

Pectin substituted for imported fats and petrolatum. May use hot or cold method after rubbing the pectin with a little alcohol and adding water.

Reichert, Benno 1937

Uber Pektinstaffe und ihre Verwendung.

Deutch. Apoth. Ztg., 52, p. 1232.

Products of hydrolysis of pectin shown by a graphic scheme.

Statement that pectin may make up to 50% of

Sauer, E. and Sanzenbacher, K. 1937

Pektin als Schutzkolloid.

Kolloid Z., 79, p. 55-63; (Chem. Abs. 31, 6951)

Pectin most abundant ingredient next to cellulose in cell wall. Found in all plants. A hydro philic colloid. Acid in reaction and negatively charged. Prolonged heating at 60° decreases the niscosity due to chemical decomposition. Neutral salts have no effect on its solutions.

Belcot, Emil 1938

Neue Substanzen, die Zur Herstellung von Pomaden, Cremes und Emulsionen verwendet werden.

Curierul. Farmac. 8, #2, 18-26; #3, 1-6 (Chem. Zentr. 1938, II, p. 3171)

Hydrogenated Peanut oil, Eucerin, Vaseline, Cholesterin, Lecithin, Pectin, Cetyl Alcohol, Triethanolamine, Glyceryl Monostearate, Aluminum Hydroxide, "Kaogel", Bentonite and Silica Gel are suggested for use in cosmetic and medicinal formulas.

Burovaya, L. N. 1938

Enzymatic Precipitation of Pectin in Fruit Juices.

Biokhimiya 3, p. 522-28; (Chem. Abs., 33, 766)

Use of pectose of clover leaves to precipitate or gel different fruit juices.

Cultera, R. and Bellini, B. 1938

Use of Pectin in Cheese Making.

Ann. Chim. Applicata, 28, 389; (Chem. Abst., 33, 2601)

Pectin used in cheese manufacture.

Haynes, Edith, Tomkins, Charles A., Crook Grace W. and Winters, Matthew 1938

Bactericidal Action of Pectin Containing Nickel.

Proc. Soc. Expt. Biol. Med., 39, p. 478; (Chem. Abs. 33, 7487)

Pectin containing 0.22% or more Nickel after autoclaving and adjusting to $_{p}H$ 5-5.5 exhibits inhibitory action on Staph. aureus; S. paradysenteriae, Flexner; P. aeruginosa; E. Caratovora and hemostreptococcus as well as E. coli but not on diplostreptococcus. Those pectins without nickel did not act as such.

Ripa, R. and Masarek, A. 1938

The Pectins

Chem. Obzov. 13, p. 65-9;

Article covers the physical and chemical properties, the chemical constitution, the decomposition products and the effects of enzymes

on pectins.

Thompson, James, E. M. 1938

Pectin in the Treatment of Infected Wounds.

Ind. Med., 7, p. 441 #7.

Use of 2% flake pectin in distilled water to accelerate healing of infected soft tissue wounds, pressure sores, ulcers, burns and compound fractures. Solution is autoclaved 15 minutes at 20# pressure and sealed until use. Dr. George Covey given credit for first use on burn grafts.

Tritton, S. M. 1938

Pectin, its source, production and use in food Manufacture.

Food Manuf. 13, p. 417-21.

Suggestions of use of pectin in emulsions, salad dressings.

Arnold, Lloyd 1939

The Influence of the Ingestion of Nickel Pectinate Upon the Growth of Growing Rats.

Am. J. Digestive Diseases and Nutrition, 6, p. 103.

80 mg. of Nickel as Nickel Pectinate (1256 mg. per kilogram of body weight) did not influence the growth curve of young rats over an eight

week period of observation.

Arnold, Lloyd 1939

The Bacteriocidal Action of Pectins and Metal Pectinates.

Am. J. Digestive Diseases and Nutrition, 6, p. 10405.

Pectin is not bacteriocidal alone but the metal pectinates (Ni, Mn, Pb, Zn, Co, Ag, Cu) are non-toxic, non-irritating bacteriocidal compounds in which the silver compound is the most effective against B. typhosa and Staph. albus and the copper compound against Staph. aureus.

Black, Louis H., Tarnowski, Alex. and Green, Bern. H. 1939

Pectin and Nickel Pectin in Acute and Chronic Bacterial Dysentery.

Am. J. Digest. Diseases and Nutrition, 6, p. 96.

Good results in majority of 95 cases of bacterial dysentery treated with Nickel Pectin. Pure pectin of no value.

Fantus, B. and Dyneiwicz, H. A. 1939

Pastes, I for Dermatological Use. Preliminary Report.

J. Am. Pharm. Assoc., 28, p. 548-54.

Formulas for dense and thin pectin pastes given with their flow times.

Gartside, H. 1939

Solutions of Gum Acacia.

Quar. J. of Pharm. and Pharmacol., 12, p. 550-62.

Method of preparing a stable acacia solution, isotonic and $_{p}H$ adjusted to 7.0-7.2, for parenteral use. Ca $(O\ H)_2$ or Na O H used to adjust $_{p}H$.

Solution has a viscosity less than that of whole blood but greater than blood serum at 37° C.

No toxic effects noted on rabbits and mice.

Jackson, Robt. L. and Frayser, Lois 1939

The Effect of Acacia on the Blood.

J. Pharmacol., 65, p. 440-52; (Chem. Abs., 33, 4674)

The body compensates acacia by storing it in parenchymatous tissue and either stores or destroys plasma protein to interfere with normal function. Plasma and blood volume are increased after acacia is given intravenously and total proteins decrease. Acacia level decreases rapidly but traces are found for one year or more. Some acacia is deposited in liver, kidney, spleen, muscles, lumph nodes and bone marrow.

Fibrinogen may be lowered and cause an increase in clotting time.

Kortshak, Hugo P. 1939

Electrolytes and Viscosity of Pectin Solutions.

J. Am. Chem. Soc., 61, p. 2313. (Chem. Abs. 33, 9089)

Experiments run upon addition of Na OH, $Ca(OH)_2$, KOH, HCl, aconitic acid, citric acid, Na Cl, K Cl, Li Cl, $Ca Cl_2$, $Na NO_3$ and $K Cl O_4$. The addition of an alkali causes an increase in viscosity--probably by formation of a salt of the pectin acid.

Kortshak, Hugo P. 1939

Citrates and the Viscosity of Pectin Solutions.

J. Am. Chem. Soc., 61, p. 681; (Chem. Abs. 33, 5217)

Lemon pectin used. Viscosity is maximum at a low citrate concentration. Minimum viscosity at a point where equal concentrations of pectin and citric acid are taken--indication of a chemical combination.

Experiments carried out with no heating and at 27.5°C.

Lesser, M. A. 1939

Pectin.

Drug and Cosm. Ind., 45, p. 549-54.

Formula for a tooth paste given. Pectin more stable than tragacanth but must avoid alkaline compounds in the paste, may use acid sub-

stances.

Pectin is 20-30% of pulp of many fruits, beet pulp is 50% or more. Pectin forms conjugation products with toxic materials and also is a hydrophilic colloid with great absorptive properties.

Quotations from 30 references.

Prickett, Paul S. and Miller, Norman J. 1939

Effect of Pectin on Bacterial Growth.

Proc. Soc. Expt. Biol. and Med., 40, p. 27-28.

Some inhibition of colony group with natural $_{p}H$ 5.5-3.9 and lesser inhibition on a broth adjusted to $_{p}H$ 6.5.

Some commercial pectins contain fermentable carbohydrates as fillers to standardize the grade of pectin.

Schenk, D. 1939

Gelierkraft der Pektine in der Kalte.

Deutch. Apoth. Ztg. 54, p. 187.

Comparative experiments with like samples of commercial pectin, one heated and the other kept at --12° C. for seven days showed an increase in jelly-forming power for the refrigerated sample.

Spalding, Clarence G. 1939

A Patent.

U. S. Patent 2145016, Jan. 24, 1939; (Chem. Abs., 33, 3017)

A method for incorporating pectin in bakery goods, cereals and breakfast foods.

Winters, Matthew, Peters, G. A. and Crook, G. W. 1939

Pectin as a Prophylactic and Curative Agent for Peptic Ulcers Produced Experimentally by Cincophen.

Amer. J. Digest. Diseases, 6, p. 12-15; (Chem. Abs., 33, 5912)

Experiments with 13 dogs in which 4 dogs were fed cincophen with 100% ulcer cases and 9 dogs had pectin added with only 11.1% ulcer cases. Pectin concluded to be prophylactic and curative in regard to peptic ulcers.

Falkenstein, D. F. and Jackson, R. L. 1940

The End Result of Acacia Therapy in a Case of Nephrosis.

Jour. of Pediat., 16, p. 700 (Whats New, Brief Summaries and Abstracts, March, 1941 # 803)

Upon autopsy of a 12 year old boy treated for nephrosis with 6-15% acacia solutions intravenously in which 705 Gm. were given, six years

later 50.3 Gm. of acacia were recovered from the liver; 2.85 Gm. from spleen. Serum protein had fallen from 4.7 Gm. to 1.5 Gm. per 100cc.

Myers, Philip B., assignor to Sardik, Inc. 1940

U. S. Patent 2,155,361, April 18, 1939.

Jr. Am. Pharm. Assoc. Extracts. July, 1940, 334.

Pectinates of Ni, Pb, Cu, Mn, Co, Zn, and Ag may be used as therapeutic bactericides in salves, ointments and aqueous solutions.

Picon, M. 1940

Emulsions injectables.

J. Pharm. Chim. 9 2, p. 49-55; (Chem. Abs. 34, 6765)

Emulsions are found to be injectable with no bad effects even in fairly large amounts.

Rosen, Karl B. 1940

Pectin Pastes.

Bulletin of the National Formulary Committee 9, #1, 35-39.

An account of experiments on pectin pastes to be accepted for N. F. VII.

Editor 1940

Pectin in Pharmacy

Am. Prof. Pharm. 6, #5, p. 310.

Eight uses of pectin in pharmacy listed: Bactericidal; Source of Galacturonic Acid, a detoxifying Mechanism for intestinal canal; Hydrophilic Colloid; Buffering action on milk to make it more readily digestable; soothing and healing to inflammed and ulcerated tissues; Reduces blood coagulation time; Helps to relieve constipation.

Deno, Richard A. 1941

Ersatz Blood.

Jr. Amer. Pharm. Assoc., Pract. Ed., 2, p. 12-16.

Blood replacements are effective in following declining order: Blood plasma; Blood serum; Hemoglobin-Ringer's solution; Acacia in physiological salt solution; Red blood cells suspended in isotonic salts solution, Physiological salt solution; and Isotonic solution of glucose.

A 6% solution of acacia has an osmotic pressure and viscosity approaching that of whole blood. Acacia varies in quality and leaves blood stream rapidly.

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DATE June 11, 1941