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NOTICE OF ENTITLEMENT

We, CAMBRIDGE BIOTECH CORPORATION of 365 Plantation Street, Biotechnology Research Park, Worcester, Massachusetts, 01605, United States of America state the following in connection with Australian Application No. 46,649/93.

The person nominated for the grant of the patent (CAMBRIDGE BIOTECH CORPORATION) has entitlement from the actual inventors CHARLOTTE A. KENSIL; SEAN SOLTYSIK; DANTE J. MARCIANI by Assignment.

The person nominated for the grant of the patent (CAMBRIDGE BIOTECH CORPORATION) has entitlement from the applicants of the application listed in the declaration under Article 8 of the PCT on the basis of Assignment.

The basic application listed in the declaration under Article 8 of the PCT is the first application made in a Convention country in respect of the invention.

DATED this 19th day of June, 1995.

CAMBRIDGE BIOTECH CORPORATION
By their Patent Attorneys
PETER MAXWELL & ASSOCIATES

P. F. MAXWELL

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(56) Prior Art Documents
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(57) Claim

1. A pharmaceutical composition for enhancing the uptake across mucous membranes of an animal of a pharmacologically active substance, wherein said pharmaceutical composition does not elicit an immune response, comprising

(a) chemically modified saponin or fraction thereof obtainable from a crude *Quillaja saponaria* extract, wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is reduced to methylenealcohol or a methyleneamino group; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the fatty acid arabinose moiety or the fatty acid rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment; or wherein the chemically modified saponin or fraction

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thereof comprises at least one of QA-17, QA-18, QA 21, QA 21 V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA 18, QA-21, QA-21-V1 and QA-21-V2 is reduced to methylenealcohol or a methyleneamine group and wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA 21 V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment;

(b) a pharmacologically active substance, and optionally

(c) a pharmaceutically acceptable carrier.

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(54) Title: METHODS FOR ENHANCING DRUG DELIVERY WITH MODIFIED SAPONINS

(57) Abstract

Methods for enhancing the transport of pharmacologically active substances across mucous membranes of an animal by administration of pharmaceutical compositions comprising modified saponins or fractions thereof obtainable by modification of a crude *Quillaja saponaria* extract or by modification of purified saponins obtainable from a crude *Quillaja saponaria* extract. Also disclosed are modified saponins having reduced irritability wherein the fatty acid moiety is removed by hydrolysis or the aldehyde group is reduced. Also disclosed are pharmaceutical compositions comprising the modified saponins of the invention.

METHODS FOR ENHANCING DRUG DELIVERY WITH MODIFIED SAPONINS

FIELD OF THE INVENTION

The present invention is in the field medicinal chemistry. In particular, the invention relates to the use of modified saponins for enhancing drug delivery across mucosal membranes of an animal. The modified saponins of the present invention exhibit significantly reduced irritation to mucosal membranes compared to the natural saponins.

BACKGROUND OF THE INVENTION

It is known that certain small peptides can be absorbed through the nasal mucosa as a "snuff" or directly from aqueous solution. Gordon, G.S. *et al.*, *Proc. Natl. Acad. Sci. USA* 82:7419-7423 (1985). However, the efficacy of absorption is typically low and variable and therapeutically important peptides of larger molecular size, such as insulin, are not absorbed to any appreciable degree. Hirai *et al.*, *Diabetes* 27:296-299 (1978).

A number of researchers have attempted to enhance the delivery of polypeptides with detergents. For example, Gordon, G.S. *et al.*, *Proc. Natl. Acad. Sci. USA* 82:7419-7423 (1985), report that the nasal absorption of insulin can be enhanced by hydrophobic bile salts.

Longenecker, J.P. *et al.*, *J. Pharm. Sci.* 76:351-355 (1987), disclose that sodium taurodihydrofusidate is an effective enhancer of mucosal permeation of drugs, in particular, insulin.

Morimoto, K. *et al.*, *J. Pharm. Pharmacol.* 37:134-136 (1984), disclose that the nasal absorption of insulin and calcitonin may be enhanced with polyacrylic acid gel.

See also Moses, A. C. *et al.*, *Diabetes* 32:1040-1047 (1983), who disclose the administration of insulin as part of an insulin-bile salt aerosol; and Aungst, B. J. *et al.*, *J. Pharm. Exp. Ther.* 244:23-27 (1988), who

compared the nasal, rectal, buccal, sublingual and intramuscular insulin efficacy and the effects of a bile salt absorption promoter.

Maitani, Y. *et al.*, *Drug Design Del. 1*:65-70 (1986), disclose the intranasal administration of β-interferon with and without surfactants (non-ionic, anionic and amphoteric). When no surfactant was used, β-interferon was not absorbed in rabbits. Sodium glycocholate was the most effective in enhancing the absorption of interferon following nasal administration. However, the total absorption of β-interferon with sodium glycocholate was 2.2% of the total absorption by intravenous administration.

Other detergents which have been employed to enhance the uptake of polypeptides by mucosal tissue include saponins. Saponins occur widely in plant species (over 400) and exhibit a range of biological properties, some of which are beneficial and some deleterious. When agitated in water, they form a soapy lather and it is this characteristic that gives the group its name. Other properties generally ascribed to saponins include, for example, hemolytic activity, cholesterol-binding properties and bitterness. For a review of the chemistry and a biological significance of saponins, reference is made to Price, K.R. *et al.*, *CRC Crit. Rev. Food Sci Nutr. 26*:27 (1987).

Solutions of saponin have been employed to enhance the delivery of polypeptides across mucosal membranes. For example, Pillion, D.J. *et al.*, *Invest. Opthal. Vis. Sci. 32*:3021-27 (1991) disclose that administration of insulin in eyedrops containing unpurified saponin from *Gypsophilla* as a 1% solution causes a rapid and reproducible reduction in the blood levels of D-glucose in rats. Insulin eyedrops lacking saponin were ineffective. Japanese Abstract No. JP 62126135 (1987) discloses the nasal administration of growth hormone releasing factor employing a saponin having a steroidal or triterpene structure. *See also*, Chiou, G. C. Y. *et al.*, *J. Pharm. Sci. 78*:815-8 (1989); and Chiou G. C. Y. *et al.*, *J. Ocul. Pharm. 5*:81-91 (1989) who disclose the systemic delivery of insulin by

administration as part of eyedrops containing saponin (obtaine from Sigma Chemical Company). *See also*, Chiou, G. C. Y. *et al.*, *Diabetes Care 11*:750-51 (1988) (source of saponin undisclosed). *See also*, Hirari, S. *et al.*, *Int. J. Pharm. 9*:173-84 (1981) and Hirari, S. *et al.*, *Int. J. Pharm. 9*:165-72 (1989), who disclose the nasal administration of insulin in rats with a solution comprising saponin (source not disclosed other than the saponin was obtained from the Wako Pure Chemical Ind., Ltd, Osaka, Japan).

While surfactants hold great promise for enhancing the uptake of drugs across mucosal membranes, a major drawback is that they cause irritation. Thus, the long-term use of pharmaceutical compositions comprising a surfactant may not be possible. However, for acute therapies, local effects are less important because the mucosal membrane can easily repair itself. Long-term local toxicity effects are even more important when enhancers are used to increase nasal membrane permeability. Chronic erosion of the mucous membrane by certain surfactants such as polyoxyethylene-9 lauryl ether could result in inflammation, hyperplasia, metaplasia and deterioration of normal nasal functions. Lee, W. A. and Longenecker, J. P., *BioPharm.* 30-37 (1988).

Literature reports indicate that biosalts break down mucous membrane structure (Martin, G. P. and Marriot, C., *J. Pharm. Pharmacol. 31*:754 (1981), accelerate phospholipid and protein release from membranes (Whitmore, D. A. *et al.*, *J. Pharm. Pharmacol. 31*:277 (1979), and damage intestinal mucosa (Kimura, T. *et al.*, *J. Nut. Sci. Vitaminol. 28*:483 (1982). Chronic erosion also exposes nasal circulation to a constant stream of air-borne bacteria and related toxants. Lee, W. A. and Longenecker, J. P., *Biopharm.* 30-37 (1988). Thus, a need continues to exist for the development of new surfactants which enhance the delivery of drugs across mucosal membranes without causing irritation.

SUMMARY OF THE INVENTION

The invention relates to pharmaceutical composition for enhancing the uptake across mucous membranes of a pharmacologically active substance, comprising

(a) chemically modified saponin or fraction thereof obtainable from a crude *Quillaja saponaria* extract, wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 may be reduced to methylenealcohol or a methyleneamino group; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 may be reduced to methylenealcohol or a methyleneamino group and wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment;

(b) a pharmacologically active substance; and optionally

(c) a pharmaceutically acceptable carrier.

The invention is also directed to a method for enhancing the uptake of a pharmacologically active substance across a mucous membrane, comprising contacting said mucous membrane with a pharmaceutical composition, comprising

(a) chemically modified saponin or fraction thereof obtainable from a crude *Quillaja saponaria* extract, wherein the chemically modified

saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 may be reduced to methylenealcohol or a methyleneamino group; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 may be reduced to methylenealcohol or a methyleneamino group and wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment;

(b) a pharmacologically active substance, and optionally

(c) a pharmaceutically acceptable carrier.

DESCRIPTION OF THE FIGURES

Figure 1 depicts the structural relationships of QA-17, QA-18 and QA-21.

Figure 2A depicts a graph showing the hemolytic activity of PBS (○), QA-21 (●) and QA-21 (▲) wherein the aldehyde group is reduced to methylene alcohol. Figure 2B depicts a graph showing the hemolytic activity of QA-18-H (○), QA-21-H (●), QA-7 (□) and QA-21 (▲).

Figure 3A depicts a graph showing blood glucose levels of rats after ocular administration of 20 μl of saline. Figure 3B depicts a graph showing blood glucose levels of a rat after ocular administration of 20 μl of 0.5 % of a commercially available crude *Gypsophilla* saponin (Sigma Chemical

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Corporation) + 0.4 % porcine insulin. Figure 3C depicts a graph showing blood glucose levels of a rat after ocular administration of 20 μl of 0.5% of crude *Quillaja saponaria* saponin (purified from an aqueous extract by ultrafiltration) + 0.5% porcine insulin.

Figure 4 shows the effect of the ocular administration of 0.1% QA-21-H (without insulin) on the blood glucose levels of rats.

Figure 5 depicts the results of the ocular administration of 20 μl of 0.025% QA-21-H and 0.4% regular pork insulin on the mean of the blood glucose levels of three rats.

Figure 6 shows a graph showing the results of the ocular administration of 0.05% QA-21-H and 0.4% regular pork insulin on the mean of the blood glucose levels of three male rats.

Figure 7 depicts a graph showing the results of the ocular administration of 0.1% QA-21-H and 0.4% regular pork insulin on the mean of the blood glucose levels of four male rats.

Figure 8 depicts a graph showing the blood lowering effect of the ocular administration of 10 μl/eye, 0.01% QA-21-H and 0.4% regular pork insulin to a first rat (■); 10 μl/eye of 0.01% pure QA-21-H and 0.4% regular pork insulin to a second rat (♦); and 20 μl microliters/eye of 0.01% QA-21-H and 0.4% regular pork insulin to a third rat (x).

Figure 9A depicts a reverse phase HPLC analysis of *Quillaja saponaria* bark extract. Figure 9B depicts a reverse phase HPLC analysis of *Quillaja saponaria* bark extract after alkaline hydrolysis.

Figure 10A depicts a reverse phase HPLC analysis of purified QA-18-H obtained from QA-18 after alkaline hydrolysis. Figure 10B depicts a reverse phase HPLC analysis of purified QA-21-H obtained from QA-21 after alkaline hydrolysis.

Figure 11 depicts a graph showing the adjuvant activities of QA-21 (○), QA-21 modified at the triterpene aldehyde by reductive amination with glycine (●), QA-21 modified at the triterpene aldehyde by reductive

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amination with ethylenediamine (□), and QA-21 modified at the triterpene aldehyde by reductive amination with ethylamine (△).

Figure 12 depicts a graph showing the adjuvant activities of QA-21 (○) and QA-21 modified at the triterpene aldehyde by reduction to the corresponding methylene alcohol (●).

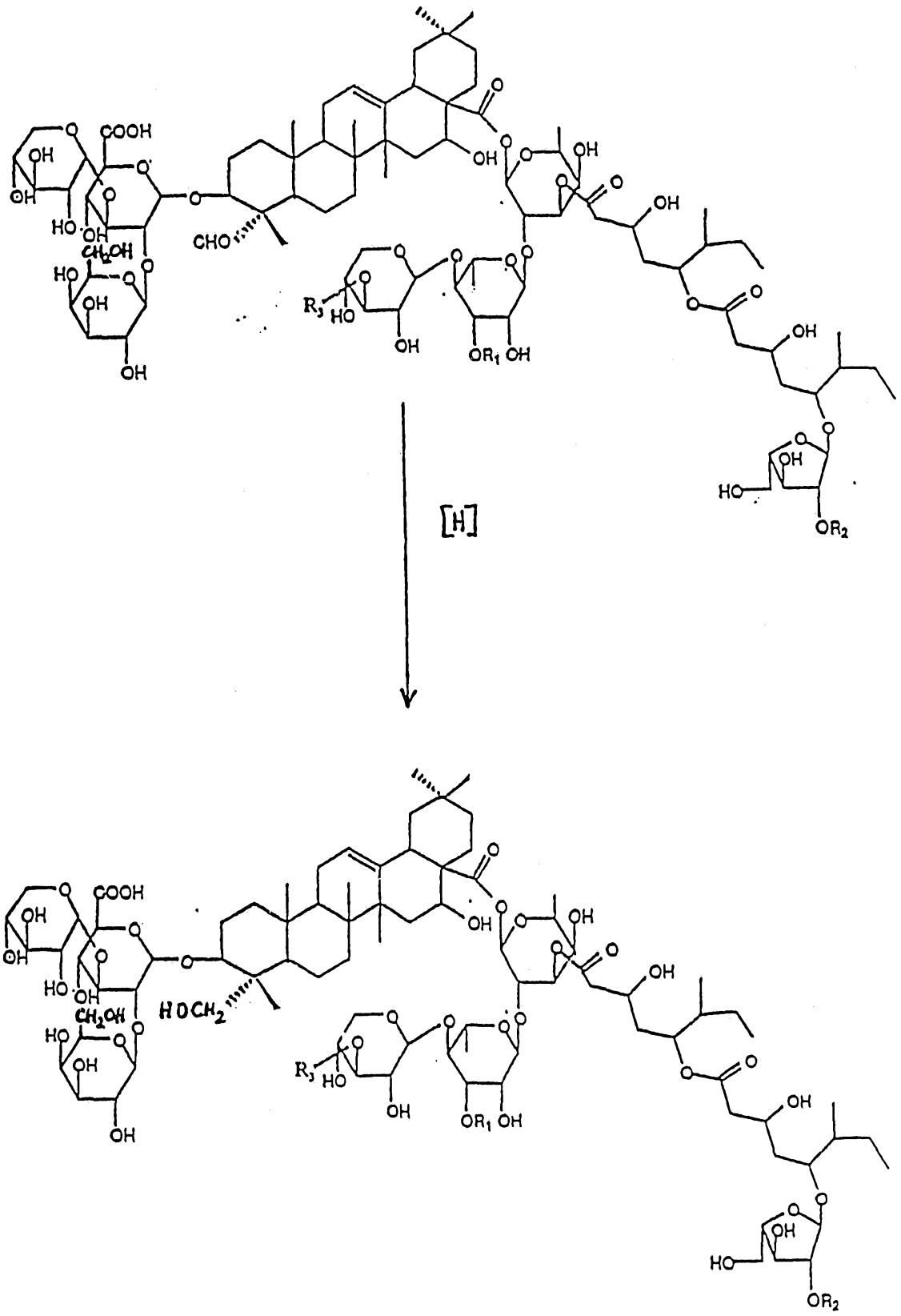
Description of the Preferred Embodiments

The present invention relates to the discovery that the irritation caused by saponins, when employed as part of a pharmaceutical composition to enhance the delivery of pharmacologically active substances across mucosal membranes, is reduced by modifying the aldehyde group of QA-17, QA-18 and QA-21, adjuvant compounds which are present in *Quillaja Saponaria Molina* Bark and which can be purified from this source.

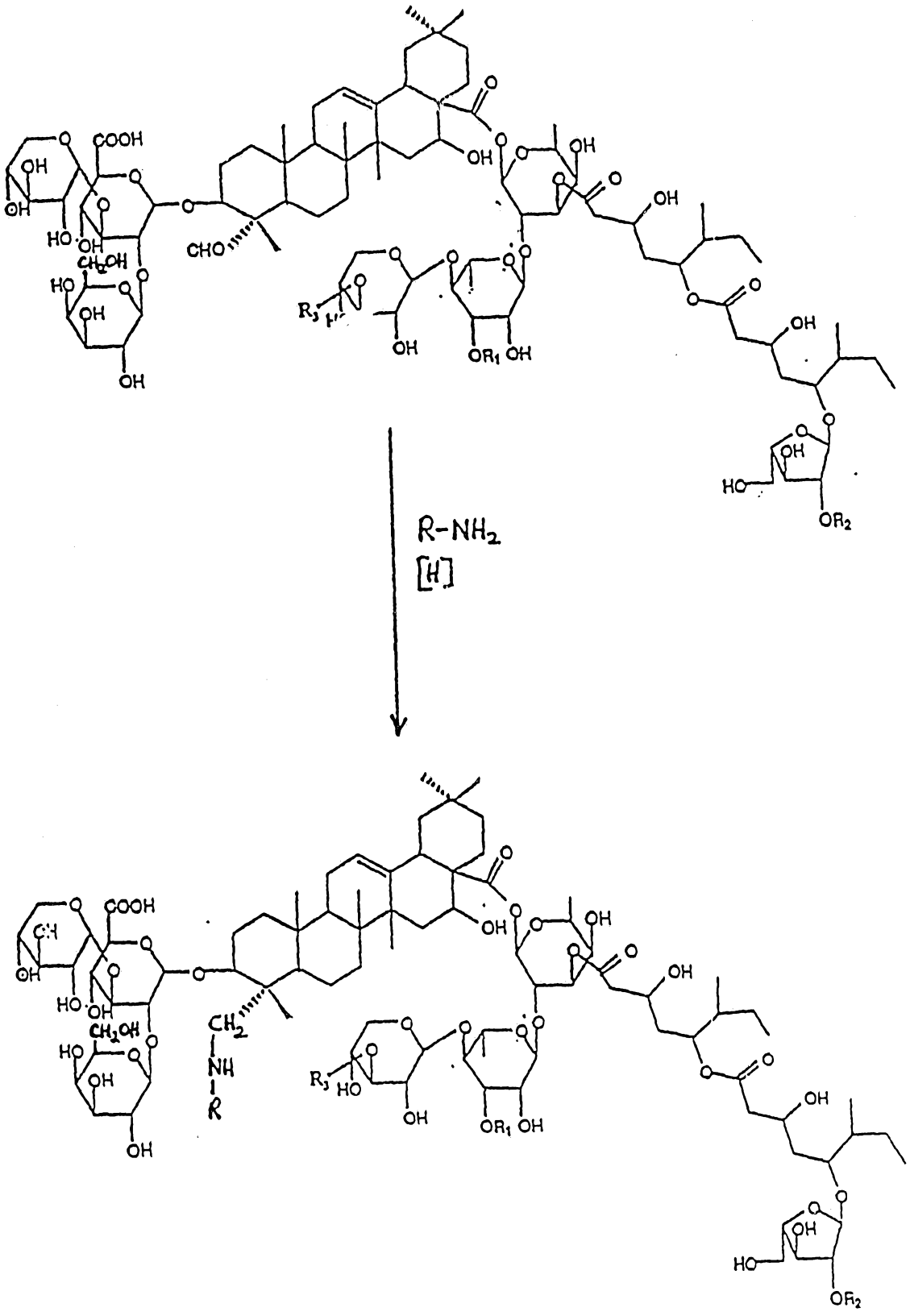
The present invention employs modified saponins which have substantially no adjuvant activity or irritability when administered to an animal, but retain sufficient lytic effect for drug transport. Such modified saponins may be obtained in several ways. In the first way, the aldehyde group of either purified QA-17, QA-18, QA-21, mixtures thereof, or purified fractions obtainable from *Quillaja Saponaria Molina* Bark and containing QA-17, QA-18 and QA-21 may be reduced with a mild reducing agent such as sodium or lithium borohydride to give the resulting alcohol. See Scheme I. Alternatively, the aldehyde of QA-17, QA-18 and QA-21, mixtures thereof, or purified fractions obtainable from *Quillaja Saponaria Molina* Bark and containing QA-17, QA-18 and QA-21, may be subjected to reductive amination with a primary amine and a reducing agent to give the corresponding amino derivative of QA-17, QA-18 and/or QA-21. See Scheme II.

Examples of primary amines which can be used in the reductive alkylation procedure include, but are not limited to methylamine, ethylamine, propylamine, ethylenediamine, propylenediamine, 2-methyl-2-aminoethylamine, 3-methyl-3-aminopropylamine, 4-methyl-4-aminobutylamine, 5-methylaminopentylamine, 6-methylaminohexylamine, 3-methylamino-2-methylpropylamine, 2-ethylaminoethylamine, 3-ethylaminopropylamine, 4-ethylaminobutylamine, 5-ethylaminopentylamine, 6-ethylaminohexylamine, 3-propylaminopropylamine, 4-propylaminobutylamine, 5-propylaminopentylamine, 6-propylaminohexylamine, 2-(N,N'-dimethylamino)ethylamine, 3-dimethylaminopropylamine, 4-dimethylaminobutylamine, 5-dimethylaminopentylamine, 6-dimethylaminohexylamine, 3-dimethylamino-2-methylpropylamine, 2-(N,N'-diethylamino)ethylamine, 3-diethylaminopropylamine, 4-diethylaminobutylamine, 5-diethylaminopentylamine, 6-diethylaminohexylamine, 3-dipropylaminopropylamine, 4-dipropylaminobutylamine, 5-dipropylaminopentylamine, 6-dipropylaminohexylamine, 5-diethylaminepentan-2-amine and amino acids such as glycine, tyrosine, phenylalanine, methionine, alanine, serine, isoleucine, threonine, valine, proline, lysine, histidine, glutamine, glutamic acid, tryptophan, arginine, aspartic acid, asparagine or cysteine.

SCHEME I



SCHEME II



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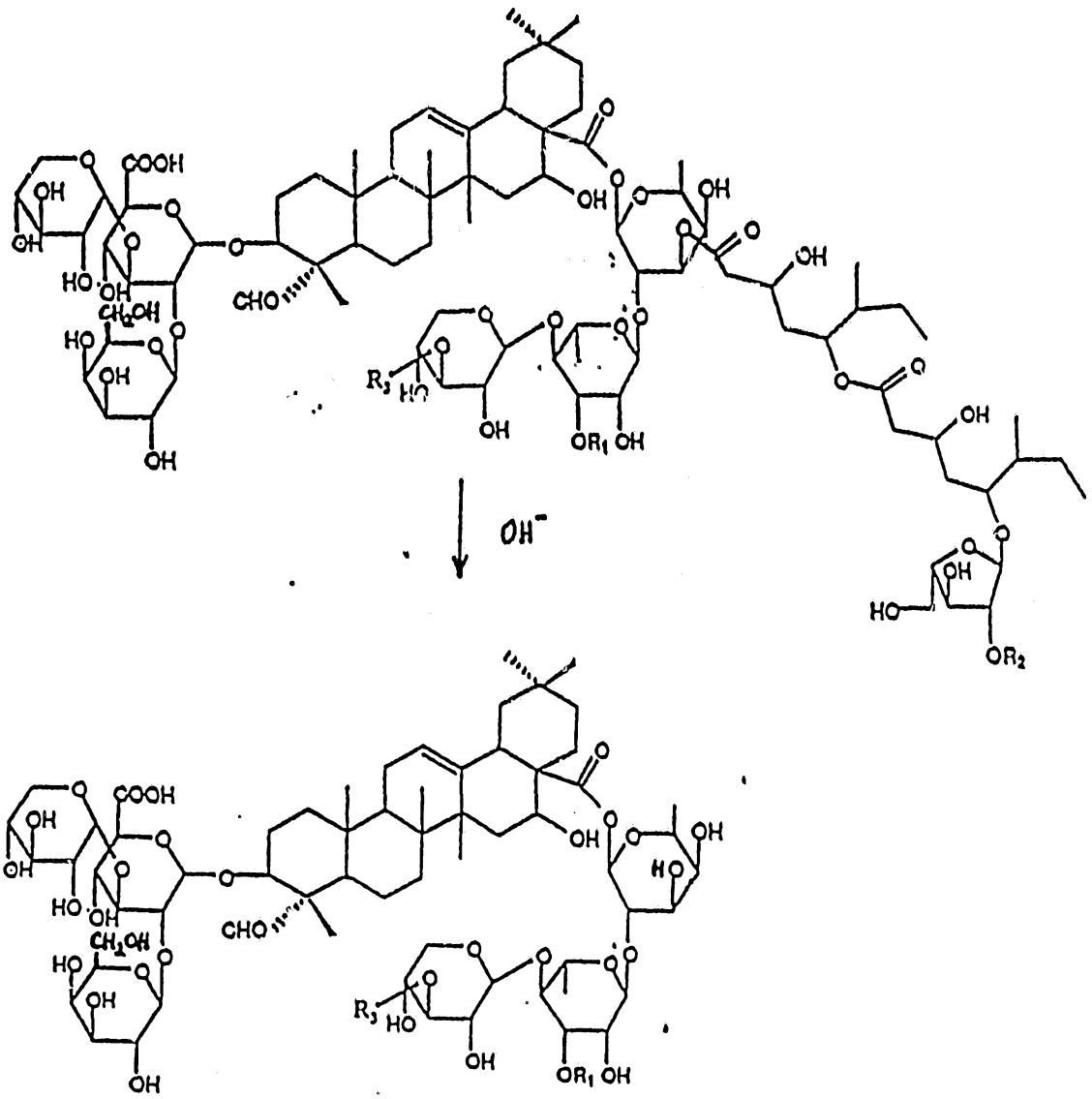
Preferably, a purified fraction of the saponin from *Quillaja Saponaria* is employed, wherein the ester side chain has been hydrolyzed to decrease adjuvant activity. See Scheme III. The products of this hydrolysis, QA-18-H and QA-21-H enhance the uptake of drugs across mucosal membranes. Such hydrolysis can be carried out from purified saponins or can be carried out with a crude mixture, with subsequent purification of the modified saponins. Figure 10 shows the reverse phase HPLC analysis of QA-18-H and QA-21-H obtained from purified QA-18 and QA-21, respectively. Figure 9 shows that QA-18-H and QA-21-H are the predominant products and can be easily purified after alkaline hydrolysis of a crude extract from *Quillaja saponaria* bark.

SCHEME III



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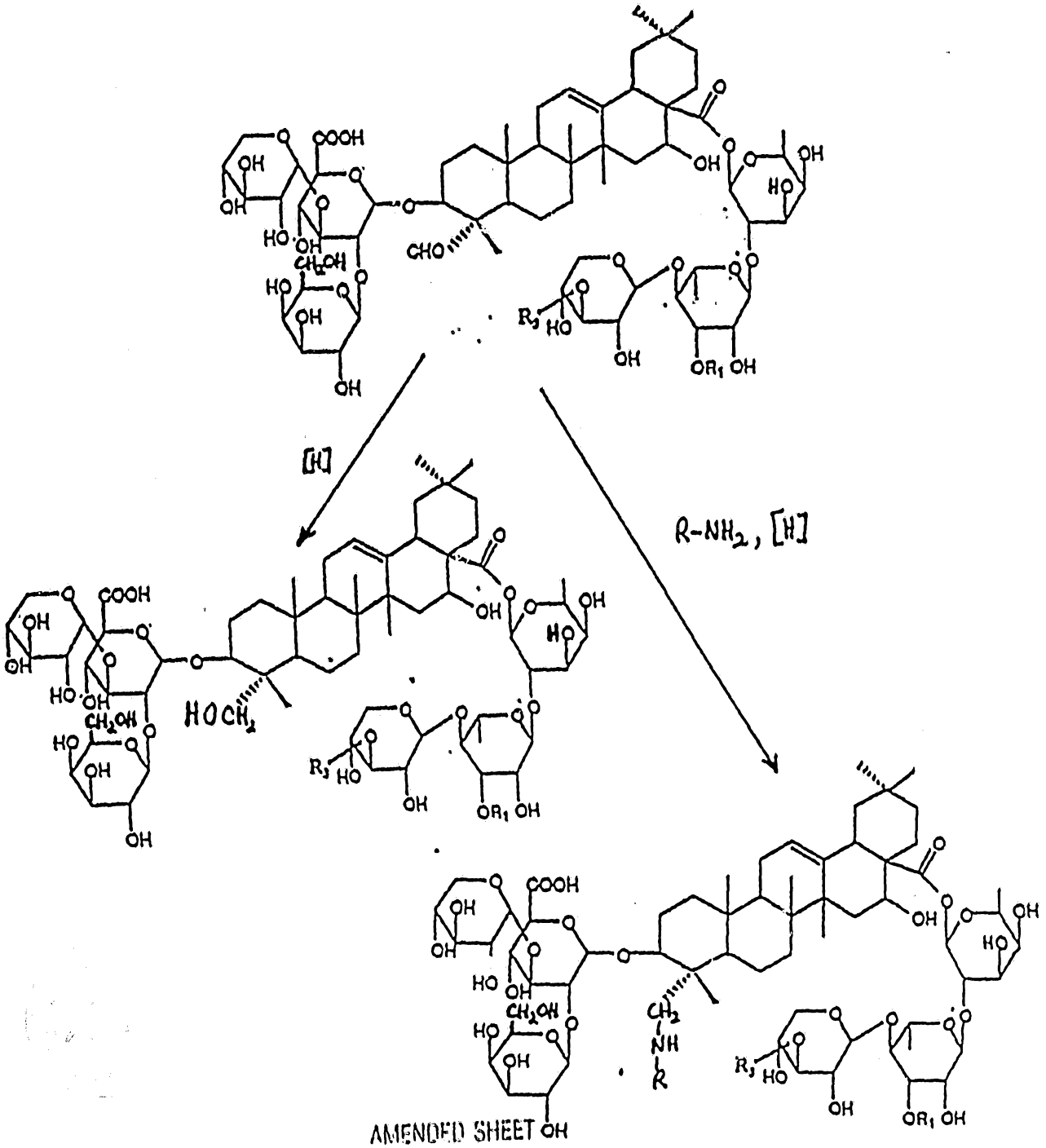
Preferably, QA-18-H and QA-21-H are further modified to reduce the inflammatory response and residual adjuvant effect. As shown in Scheme IV, the aldehyde group of QA-18-H and QA-21-H may be reduced with sodium or lithium borohydride to give the corresponding methyl alcohol. Alternatively, the aldehyde group may be subjected to reductive amination with a primary amine and sodium or lithium borohydride to give the corresponding secondary amine. See Scheme IV.

SCHEME IV



Thus, the present invention relates to pharmaceutical composition for enhancing the uptake of a pharmacologically active substance across mucous membranes, comprising

(a) chemically modified saponin or fraction thereof obtainable from a crude *Quillaja saponaria* extract, wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 may be reduced to methylenealcohol or a methylene-amino group; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 may be reduced to methylenealcohol or a methyleneamino group and wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment;

(b) a pharmacologically active substance, and optionally

(c) a pharmaceutically acceptable carrier.

The amino groups have the formula -N(R)-R', wherein R is hydrogen; R' is selected from the group consisting of hydrogen, C_{1-8} alkyl, C_2-C_{12} alkylaminoalkyl, allyl, aralkyl, C_3-C_8 cycloalkyl, aryl and a group having the formula

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R"
|
-CH-CO_2H,

wherein R" is hydrogen, C_{1-4}alkyl, or C_{1-4} alkyl substituted by phenyl, hydroxyphenyl, indolyl, mercapto, C_{1-4} alkylthio, hydroxy, carboxy, amino, guanidino, imidazolyl or carbamyl; or wherein R and R" together form a pyrrolidinyl or piperidinyl ring.

Typical C_1-C_8 alkyl groups include methyl, ethyl, n-propyl, i-propyl, n-butyl, t-butyl, i-butyl, pentyl and hexyl groups.

Typical C_3-C_8 cycloakyl groups include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, and cyclooctyl groups.

Typical aryl groups include phenyl, naphthyl, phenanthryl, anthracyl and fluorenyl groups.

Typical aralkyl groups include a C_1-C_8 alkyl group substituted by one of the above-listed aryl groups, e.g. phenethyl, phenylpropyl, phenylbutyl, phenylpentyl and phenylhexyl groups as well as the branched chain isomers thereof.

Typical C_2-C_{12} alkylaminoalkyl groups include 2-methylaminoethyl, 3-methylaminopropyl, 4-methylaminobutyl, 5-methylaminopentyl, 6-methylaminohexyl, 3-methylamino-2-methylpropyl, 2-ethylaminoethyl, 3-ethylaminopropyl, 4-ethylaminobutyl, 5-ethylaminopentyl, 6-ethylaminohexyl, 3-propylaminopropyl, 4-propylaminobutyl, 5-propylaminopentyl, 6-propylaminohexyl, 2-(N,N'-dimethylamino)ethyl, 3-dimethylaminopropyl, 4-dimethylaminobutyl, 5-dimethylaminopentyl, 6-dimethylaminohexyl, 3-dimethylamino-2-methylpropyl, 2-(N,N'-diethylamino)ethyl, 3-diethylaminopropyl, 4-diethylaminobutyl, 5-diethylaminopentyl. 6-diethylaminohexyl, 3-dipropylaminopropyl, 4-dipropylaminobutyl, 5-dipropylaminopentyl, 6-dipropylaminohexyl, 5-diethylaminepentan-2-yland the like.

According to U.S. Patent No. 5,057,540, the contents of which are fully incorporated by reference herein, saponins may be purified from an

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aqueous extract of the bark of the South American tree, *Quillaja saponaria Molina*. At least 22 peaks with saponin activity were separable. The predominant purified *Quillaja* saponins are QA-7, QA-17, QA-18, and QA-21. These saponins have been purified by high pressure liquid chromatography (HPLC) and low pressure silica chromatography. QA-21 may be further purified using hydrophilic interaction chromatography (HILIC) and resolved into two peaks, QA-21-V1 and QA-21-V2, which are different compounds. Thus, "QA-21" designates the mixture of components QA-21-V1 and QA-21-V2 which appear as a single peak on reverse phase HPLC on Vydac C4 (5 μm particle size, 330 Å pore, 4.6 mm ID x 25 cml) in 40 mM acetic acid in methanol/water (58/42, v/v). The component fractions are referred to specifically as QA-21-V1 and QA-21-V2 when describing experiments or results performed on the further purified components.

In order to purify saponins from *Quillaja saponaria Molina* bark, aqueous extracts of the *Quillaja saponaria Molina* bark are dialyzed against water. The dialyzed extract is lyophilized to dryness, extracted with methanol and the methanol-soluble extract is further fractionated on silica gel chromatography and by reverse phase high pressure liquid chromatography (RP-HPLC). The individual saponins are separated by reverse phase HPLC. At least 22 peaks (denominated QA-1 to QA-22) are separable. Each peak corresponds to a carbohydrate peak which exhibits only a single band on reverse phase thin layer chromatography. The individual components were identified by retention time on a Vydac C_4 HPLC column as follows:

Peak	Retention Time (minutes)
QA-1	solvent front
QA-2	4.6
QA-3	5.6
QA-4	6.4
QA-5	7.2
QA-6	9.2
QA-7	9.6
QA-8	10.6
QA-9	13.0
QA-10	17.2
QA-11	19.0
QA-12	21.2
QA-13	22.6
QA-14	24.0
QA-15	25.6
QA-16	28.6
QA-17	35.2
QA-18	38.2
QA-19	43.6
QA-20	47.6
QA-21	51.6
QA-22	61.0

The substantially pure QA-17 saponin is characterized as having adjuvant activity, containing about 29% carbohydrate (as assayed by anthrone) per dry weight, having a UV absorption maxima of 205-210 nm, a retention time of approximately 35 minutes on RP-HPLC on a Vydac C_4 column having 5 μm particle size, 330 Å pore, 4.6 mm ID x 25 cm L in a solvent of 40 mM acetic acid in methanol-water (58/42; v/v) at a flow rate of 1 ml/min, eluting with 63-64% methanol from a Vydac C_4 column having 5 μm particle size, 330 Å pore, 10 mm ID x 25 cm L in a solvent of 40 mM acetic acid with gradient elution from 50 to 80% methanol, having a critical micellar concentration of .06% (w/v) in water and .03% (w/v) in phosphate buffered saline, causing hemolysis of sheep red blood cells at 25 μg/ml or greater, and containing the monosaccharide residues

terminal rhamnose, terminal xylose, 2-fucose, 3-xylose, 3,4-rhamnose, 2,3-glucuronic acid, terminal glucose, 2 - arabinose, terminal galactose and apiose (linkage not determined).

The substantially pure QA-18 saponin is characterized as having immune adjuvant activity, containing about 25-26% carbohydrate (as assayed by anthrone) per dry weight, having a UV absorption maxima of 205-210 nm, a retention time of approximately 38 minutes on RP-HPLC on a Vydac C_4 column having 5 μm particle size, 330 Å pore, 4.6 mm ID x 25 cm L in a solvent of 40 mM acetic acid in methanol/water (58/42; v/v) at a flow rate of 1 ml/min, eluting with 64-65% methanol from a Vydac C_4 column having 5 μm particle size, 330 Å pore, 10 mm ID x 25 cm L in a solvent of 40 mM acetic acid with gradient elution from 50 to 80% methanol, having a critical micellar concentration of .04% (w/v) in water and .02% (w/v) in phosphate buffered saline, causing hemolysis of sheep red blood cells at concentrations of 25 μg/ml or greater, and containing the monosaccharides terminal arabinose, terminal apiose, terminal xylose, terminal glucose, terminal galactose, 2-fucose, 3-xylose, 3,4-rhamnose, and 2,3-glucuronic acid.

The substantially pure QA-21 saponin is characterized as having immune adjuvant activity, containing about 22% carbohydrate (as assayed by anthrone) per dry weight, having a UV absorption maximum of 205-210 nm, a retention time of approximately 51 minutes on RP-HPLC on a Vydac C_4 column having 5 μm particle size, 330 Å pore, 4.6 mm ID x 25 cm L in a solvent of 40 mM acetic acid in methanol/water (58/42; v/v) at a flow rate of 1 ml/min, eluting with 69 to 70% methanol from a Vydac C_4 column having 5 μm particle size, 330 Å pore, 10 mm x ID 25 cm L in a solvent of 40 mM acetic acid with gradient elution from 50 to 80% methanol, with a critical micellar concentration of about .03% (w/v) in water and .02% (w/v) in phosphate buffered saline, and causing hemolysis of sheep red blood cells at concentrations of 25 μg/ml or greater. The component fractions, substantially pure QA-21-V1 and QA-21-V2 saponins, have the same molecular weight and identical spectrums by FAB-MS. They differ only in

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that QA-21-V1 has a terminal apiose which is xylose in QA-21-V2 (which therefore has two terminal xyloses and no apiose). The two components additionally contain the monosaccharides terminal arabinose, terminal apiose, terminal xylose, 4-rhamnose, terminal galactose, 2-fucose, 3-xylose, and 2,3-glucuronic acid.

The alkaline hydrolysis products may be prepared as follows. Treatment of QA-18 by brief alkaline hydrolysis yielded one major carbohydrate-containing alkaline hydrolysis product (designated QA-18-H). Purified QA-18-H was prepared from QA-18 and isolated in the following manner:

One ml QA-18 (5 mg/ml) was incubated with 25 μl 1 N NaOH for 15 minutes at room temperature. The reaction was stopped with the addition of 100 μl 1 N acetic acid. Using these hydrolysis conditions, QA-18 was completely converted to a major hydrolysis product (QA-18-H) eluting in a peak with retention time of 8.0 min compared to 66.8 min for unhydrolyzed QA-18, indicating the increased hydrophilicity of QA-18-H. (Chromatography on Vydac C_4 (4.6 mm ID x 25 cm L) in 0.1% trifluoroacetic acid in 55/45 methanol/water v/v) and eluted in a gradient to 64/36 methanol/water (v/v) over 180 minutes, flow rate of 1 ml/minute). The peak containing pure QA-18-H (retention time 8.0 min) was pooled for further characterization. The hydrolysis product of QA-21, designated QA-21-H, was prepared and purified in the same manner. QA-21-H had a retention time of 9.3 minutes compared to 80.4 minutes for unhydrolyzed QA-21. These hydrolysis products were shown by retention time on HPLC and by reverse phase thin layer chromatography to be identical to the major hydrolysis products generated using the method of Higuchi *et al.*, *Phytochemistry* 26:229 (1987) using mild alkaline hydrolysis in NH_4HCO_3 (Table 5). In addition, these products, QA-18-H and QA-21-H, were shown to be the major breakdown products from hydrolysis of "Quil-A", a crude saponin mixture containing QA-7, QA-17, QA-18, and QA-21 as well as other saponins, indicating that

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the hydrolysis products QA-21-H and QA-18-H are the same hydrolysis products isolated by Higuchi *et al.*, *supra*, for structural characterization.

TABLE 5

Retention Time of Major
Alkaline Hydrolysis Products

QA-17-H	8.0[a]
QA-18-H	8.0[a]
	8.2[b]
QA-21-H	9.3[a]
	9.5[b]
Hydrolyzed - "Quil-A"	8.2[a], 9.3[a]

[a] Cambridge BioScience hydrolysis conditions: 5 mg/ml saponin, pH 13, reaction time = 15 minutes at room temperature

[b] Higuchi *et al.* hydrolysis conditions: 5 mg/ml saponin, 6% NH_4HCO_3, methanol/ H_2O (1/1, v/v), reaction time = 60 minutes at 100°C

HPLC Conditions: Vydac C4, 5 μm particle size, 300 Å pore size, .46 x 25 cm

Solvent A = 0.1% trifluoroacetic acid in water
Solvent B - 0.1% trifluoroacetic acid in methanol

Gradient = 55 - 64% B/ 180 minutes
Flow rate - 1 ml/min

The compositions of the invention comprising the modified saponins may be employed to enhance the uptake across mucosal membranes of any one of a large number of pharmacologically active substances. Preferably, such pharmacologically active substances are polypeptides, however, the invention is not intended to be so limited. The compositions comprising the modified saponins of the invention may be used to enhance the uptake of any pharmacologically active substance, so long as its molecular weight is less than about 200,000.

Examples of such polypeptides which may be administered together with the compositions of the present invention include, but are not limited to, insulin, insulin-like growth factor, growth hormone, parathyroid hormone, renin, prolactin, thyroid stimulating hormone, corticotrophin, follicle stimulating hormone, chorionic gonadotropin, luteinizing hormone, luteinizing releasing factor, interferon (alpha, beta and gamma), lymphokines, interleukin, tumor necrosis factor, antibodies (monoclonal and polyclonal), e.g. IgG, enkephalins (see Su, K.S.E., *et al., J. Pharm. Sci. 74*:394-98 (1985)), calcitonin (McMartin, C. and Peters, G., *Delivery Systems For Peptide Drugs*, S.S. Davis *et al.* (eds.), pp. 249-53, Planum Press New York (1986)), somatostatin (McMartin, C. and Peters, G., *Delivery Systems For Peptide Drugs*, Davis, S.S., *et al.* (eds.), pp. 255-63, Planum Press New York (1986)), methionyl growth hormone (Moore, J.A. *et al., Delivery Systems For Peptide Drugs*, Davis, S.S., *et al.* (eds.), pp. 317-329, Planum Press New York (1986)), oxytocin (Hendricks, C.H. and Pose, S.V., *J.A.M.A. 175*:384-387 (1961), vasopressin and desmopressin (Richson, D.W. and Robinson, A.G., *Ann. Int. Med. 103*:228-239 (1985), luteinizing hormone releasing hormone (Fink, G. *et al., J. Endocr. 63*:351-360 (1974), nafarelin acetate (Anik, S.T. *et al., J. Pharm. Sci. 73*:684-685 (1984), secretin (Ohwaki, T. *et al., J. Pharm. Sci. 74*:5510-552 (1985), glucagon (Pontiroli, A.E. *et al., Acta Diabetol Let. 22*:102-110 (1985), pimolol (Kaila, T. *et al., J. Ocular Pharm. 1*:79-83 (1985), thyrotropin-releasing hormone (Sandow, J. and Petri, W., *Trans Nas. System. Med.*, (Chien, Y.W. ed.) Elsevier Science Publishers B.B., Amsterdam, pp. 183-199 (1985)).

In addition, the compositions of the present invention may also be employed to enhance the uptake across mucosal membranes of enzymes, transferases, hydrolases, isomerases, proteases, ligases and oxidoreductases such as esterases, phosphatases, glycosidases and peptidases; enzyme inhibitors such as leupeptin, chymostatin and pepstatin and growth factors such as tumor angiogenesis factor.

Other suitable pharmacologically active substances are fat-soluble steroids such as progesterone, estrogens and androg as well as the fat soluble vitamins A, D, E and K.

In addition to low and high molecular weight polypeptides, the pharmacologically active substance may be an anti-inflammatory agent (e.g., indomethacin, flurbiprofen, ketoprofen, ibuprofen, phenylbutazone), antibiotics (e.g., beta-lactams, aminoglycosides, macrolides, tetracyclines, pryridonecarboxylic acids, phosphomycin), anti-tumor agents (e.g., adriamycin, cisplatin, bleomycin, mitomycin, fluorouricil, inblastine, vincristine), amino acids (e.g., ascorbic acid, N-acetyltryptophan), antifungal agents, prostaglandins, vitamins, steroids, and antiviral agents (AZT, DDI, acyclovir, idoxuridine, amantadine, and vidarabine).

The compositions of the present invention may be applied to any mucous membrane including the conjunctiva, nasopharynx, orthopharnyx, vagina, colon, urethra, urinary bladder, lung, large (rectal) and small (enteral) intestine. The compositions of the present invention may also be administered transdermally, for example, as part of a patch. Preferably, the compositions of the present invention are administered to the eye as part of eye drops, nasally as part of an aerosol or buccally as part of a solid wafer.

In addition, the pharmaceutical compositions of the present invention may also be formulated in sustained release compositions. For example, the modified saponin and drug may be combined with a silicone elastomer which releases the saponin and drug over a long period of time. The silicone elastomer may also comprise albumin. *See* U.S. Patent No. 4,985,253, the contents of which are fully incorporated by reference herein. The release rate of the drug from the silicone elastomer can be controlled by incorporation of a water soluble or fat soluble mixing agent or cosolvent (e.g., polyethylene glycol 400, polysorbate 80, sodium alginate, L-alanine, sodium chloride, polydimethylsiloxane) into the

silicone elastomer. Any other additive may also be incorporated into the silicone elastomer for the purpose of accelerating the release rate.

In addition, the pharmacologically active substance and saponin may be formulated in a controlled release composition comprising a polylactide and/or polyglycolide copolymer, a cellulose polymer (methyl-, methylhydroxyethyl-, hydroxypropyl-, hydroxyethyl-, sodium carboxyethyl-cellulose), polyacrylic acid, polymethylmethacrylate, cross-linked polyacrylic acid, polyvinylpyrrolidone, polyvinylalcohol, polyethylene glycol, agarose or a copolymer of styrene and hydroxyethylmethacylate crosslinked with divinylazobenzene. Alternatively, the pharmacologically active substance and saponin may be formulated as part of DEAE-dextran microspheres, starch microspheres, or albumin microspheres.

When the saponin and pharmacologically active substance are formulated in a sustained release composition, the content of the pharmaceutical substance may be appropriately controlled depending upon the dose to be administered, and the release rate. When the composition is shaped in matrix type preparation, the content of the pharmaceutical substance may usually be from 5 to 40% by weight and, more preferable, not more than 15% by weight, for example 9% by weight or less. When administering a peptide hormone, the content of same should be no more than about 6 to 10% by weight. Albumin, if employed, is present at not more than 50% by weight, preferably from about 20 to 30% by weight. The silicone elastomer may be contained in an amount of not less than 50% by weight, preferably from 70 to 90% by weight.

The sustained release compositions may be prepared by mixing the components in any optional order. When albumin is added, the drug and albumin are first combined, preferably in a solid state. Alternatively, an aqueous solution of the pharmaceutical substance and albumin may be mixed and the resulting mixture lyophilized to make a solid mixture. This mixture is then dispersed uniformly with an elastomer base optionally with

a plasticizer (e.g., dimethypolysiloxane), adding a curing agent thereto and stirring the resultant mixture. The mixture is then filled in an appropriate mold, followed by curing at room temperature to give a shaped composition. In the alternative, a core material not containing a pharmaceutical substance may be covered with the composition comprising a silicone elastomer containing a pharmaceutical substance, optionally containing albumin, to make a shaped composition. Such core material may comprise any non-toxic material. Preferably, such core material is an elastic polymer.

The sustained release compositions of the present invention may have any shape which is suitable for effective contact with mucous membranes in body cavities. For example, when the pharmacologically active substance is administered sublingually, the sustained release composition may be in the form of a wafer. When the pharmacologically active substance is administered vaginally, the sustained release composition may be in the form of a ring. When administered ocularly, the sustained release composition may be in the form of thin ocular implants.

The compositions of the present invention may also be formulated as part of a chewing gum comprising the gum from the latex of the sapodilla. Preferably, the chewing gum composition also comprises sweeteners (sugar, aspartame and the like) and flavorants (spearmint, wintergreen or peppermint oil and the like) which masks any unpleasant taste associated with the pharmacologically active substance.

When administered ocularly or nasally, the compositions of the present invention may be formulated in an aqueous solution buffered to a pH of between 3.0 and 8.0, most preferably pH 5.0 - 5.4, by means of a pharmaceutically acceptable buffer system. Any pharmaceutically acceptable buffering system capable of maintaining the pH in the preferred ranges may be used in the practice of this invention. A typical buffer will be, for example, an acetate buffer, a phosphate buffer, a citrate

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buffer, a succinate buffer or the like. The concentrate of buffer may range from between 0.005 and 0.1 molar, most preferably about 0.02 molar.

When the compositions of the present invention are administered ocularly, the composition may comprise a solution containing sodium, potassium, magnesium, calcium, chloride and bicarbonate ions as well as dextrose and glutathione. See, for example, U.S. Patent Nos. 4,550,022, 4,443,432. Alternatively, the ocular fluid may comprise an aqueous solution containing sodium chloride, potassium chloride, calcium chloride and N-2-hydroxyethylpiperazine-N-2-ethanesulphonic acid. Sodium hydroxide may be included to establish a pH value of about 7.25 and magnesium sulfate may also be included. See UK Patent Application GB 2,064,320. See also U.S. Patent No. 4,938,970 which discloses irrigation solutions which do not cause pain when administered to the eye. According to this patent, the electrolyte solution comprises 2-10-meq/L of K^+, 0-meq/L of Ca^{++}, 1-meq/L of Mg^{++} and 110-150 meq/L of Na^+, buffered to a pH of 6.85 - 8.0.

Other materials such as preservatives, salts to achieve the tonic value of tissue, or other additives indicated by known nasal or ocular formulation chemistry may be added to these formulations.

By the term "animal" is intended all animals which might derive a benefit from the compositions of this invention. Foremost among such animals are humans; however, the invention is not intended to be so limiting, it being within the contemplation of the invention to treat any and all such animals which may experience the beneficial effects of the present invention.

For the purposes of nasal administration, the compositions of the invention will be preferably in a container provided with means enabling application of the contained composition to the nasal mucosa, e.g., with a nasal applicator device. Suitable applicators are known in the art and include those adapted for administration of liquid compositions to the

nasal mucosa in drop or spray form. Since dosaging with polypeptides should be as accurately controlled as possible, the use of spray applicators for which the administered quantity is susceptible to precise regulation are generally preferred. Suitable administrators include e.g., atmosing devices, e.g., pop-atomizers and aerosol dispensers. In the latter case, the applicator will contain the composition according to the present invention together with a propellant medium suitable for use in a nasal applicator. The atomizing device will be provided with an appropriate spray adaptor allowing delivery of the contained composition to the nasal mucosa. Such devices are well known in the art.

The container, e.g. nasal applicator or eye drop bottle, may contain sufficient composition for a single nasal or ocular dosaging or for supply of several sequential dosages, e.g. over a period of days or weeks.

The following examples are illustrative, but not limiting of the method and compositions of the present invention. Other suitable modifications and adaptations of the variety of conditions and parameters normally encountered in clinical therapy and which are obvious to those skilled in the art are within the spirit and scope of the present invention.

Example 1 CONJUGATION OF GLYCINE AND ETHYLENEDIAMINE TO QA-21 TRITERPENE ALDEHYDE VIA REDUCTIVE ALKYLATION

To react glycine with the QA-21 triterpene aldehyde, 20 mg of QA-21 was dissolved in 0.8 ml of 50% methanol, 50 mM sodium phosphate, pH 6.0. A 0.5 ml solution of glycine was prepared in water. A total of 0.1 ml of glycine was added to the QA-21 solution. A 0.1 M solution of sodium cyanoborohydride was prepared in methanol (32 mg in 5 ml). A total of 0.1 ml of the sodium cyanoborohydride was added to the QA-21 solution. The addition of sodium cyanoborohydride was repeated at 2.5, 21, 25 and 46 hours. The reaction mixture was purified by reverse phase HPLC. A new peak at 31.3 minutes was collected. The new product was confirmed by FAB-MS.

To react ethylenediamine with the QA-21 triterpene aldehyde, 6 mg of QA-21 was dissolved in 1 ml 50% methanol, 20 mM triethylamine phosphate, pH 6. A total of 0.15 ml of a 0.1 M ethylenediamine solution in water was added followed by 0.06 ml of 50 mM sodium cyanoborohydride in methanol. Additional aliquots of the sodium cyanoborohydride were added at 45 minutes and 16 hours. The reaction was purified by reverse phase HPLC on a 30-60% B method. A new peak at 19.6 minutes was collected. This material was freeze-dried. The resulting peak was analyzed by reverse phase thin layer chromatography and shown to be reactive with ninhydrin, indicating the addition of a free amino group to QA-21.

EXAMPLE 2 REDUCTION OF THE QA-21 TRITERPENE ALDEHYDE TO METHYLENEALCOHOL

Twelve mg of QA-21 in four ml of water was mixed with 8 ml of 0.1 M sodium phosphate, pH 6.0 for a final QA-21 concentration of 1 mg/ml. A stock solution of 1 M sodium borohydride was prepared in 0.01 M NaOH. A total volume of 0.580 ml of sodium borohydride was added to the QA-21 in small increments (approximately 50 μl increments). The final concentration of sodium borohydride was 0.05 M. This reaction mixture was incubated for one hour at room temperature. The reaction was quenched with 1 ml of 1 N acetic acid. To remove sodium borohydride, the QA-21 was absorbed to C_{18}. Four mls of reaction mixture was passed through a cartridge containing C_{18}. The cartridge was then washed with two 5 ml water washes. The QA-21 was then eluted from the C^{18} with 5 ml of methanol. This process was repeated with the remaining 8 ml of reaction mixture. The methanol was evaporated under a stream of N_2. The reduced QA-21 was then redissolved in 30% acetonitrile/0.15% trifluoroacetic acid and purified by HPLC to remove residual unreduced QA-21 (Vydac C_4, 5 μm particle size, in a gradient of

25-40% B over 60 minutes at a flow rate of 3 ml/min (Solvent A - 0.15% TFA in water, Solvent B - 0.15% TFA in acetonitrile)). The reduced QA-21 eluted with a retention time of 46.8 minutes (compared to a retention time of 48.1 minutes for unreduced QA-21). The peak corresponding to the reduced QA-21 was pooled, diluted 1/2 with water and collected on C_{18} cartridges as described above. The final product was lyophilized and used for immunization studies.

EXAMPLE 3 ADJUVANT ACTIVITIES OF MODIFIED QA-21 SAPONINS

Modified QA-21 saponins, as prepared above, were tested for adjuvant activity. C57 bl/6 mice (5 per group) were immunized subcutaneously with 25 μg ovalbumin and 10-50 μg QA-21 or one of its derivatives in saline. A booster immunization was given at day 14. Antibody response (total IgG) was tested by enzyme immunoassay after the second immunization. The two derivatives prepared by reductive alkylation at the triterpene aldehyde did not retain adjuvant activity at the doses tested (Figure 11). The modified QA-21 in which the triterpene aldehyde was reduced to an alcohol retained some adjuvant activity, but with a higher minimum effective dose than QA-21 (Figure 12). Results from similar experiments in which two booster immunizations were given at two week intervals are summarized in Table 6.

TABLE 6	
Adjuvant Activity of QA-21 and Derivatives	
Saponin (10 μg) administered with ovalbumin (10 μg)	Anti-ovalbumin IgG, Total (log titer)
none	2.59 ± 0.81
QA-21	4.06 ± 0.30
QA-21-A-ethylamine[a]	2.69 ± 0.59
QA-21-A-ethylene diamine[a]	2.68 ± 0.36
QA-21-A-glycine[a]	2.00 ± 0.19
[a]Modified at triterpene aldehyde.	

EXAMPLE 3 Hemolytic Activity of Modified Saponins

The hemolytic assay provides a rough measure of the ability of a detergent to enhance the uptake of pharmacologically active substances across mucous membranes by determining membrane permeabilization. Briefly, dilutions of the modified saponins are made on a round bottom, microtiter plate with 1:2 dilutions in phosphate buffered saline in successive rows (100 μl/well). 10 μl normal sheep blood in Alsevers solution (Whittaker) was added to each well and mixed. Plates were incubated for one hour at room temperature followed by centrifugation of the plates in a Sorvall RT6000 to sediment unhemolyzed cells. Absence of hemolysis was determined by the presence of a pellet of unhemolyzed cells in the bottom of the well. Hemolytic activity is determined by the increase of release of hemoglobulin from sheep red blood cells (measured as absorbance at 562 or 570 nm in the red blood cell supernatant).

As shown in Figure 2, QA21 substantially increases membrane permeabilization at very low concentrations. Reduced QA-21 also increase membrane permeabilization, but at a lower level and at higher concentrations compared to QA21.

EXAMPLE 4 Ocular Administration of Insulin Enhanced by Modified Saponins

Protocol:

Male Sprague-Dawley rats were anesthetized with xylasine-ketamine and 30 minutes later (time 0), eye drops composed of saline plus or minus 0.4% insulin (100 U/ml) and one of the following saponins: Sigma crude saponin extracted from *Gypsophilla* Sigma Chemical Company, St. Louis, Mo.); crude saponin extracted from *Quillaja*; QA 21-H purified saponin hydrolytic derivative from QA 21. Typically, 20 μl of eye drops were delivered to one eye but occasionally 20 μl was delivered to both eyes. Blood D-glucose levels were measured using an AccuCheck-II glucometer (Boehringer-Mannheim). Data represent the level of blood glucose at various times before and after eye drop administration. Each single line represents the data obtained from one experimental animal, except where indicated.

Results

As shown in Figure 3A, when saline was administered to the eyes of rats as a control, there was very little change in the blood glucose levels. However, when 0.5% of Sigma *Gypsophilla* saponin was coadministered with 0.4% regular pork insulin, a significant hypoglycemic effect was observed. *See* Figure 3B. When 0.5% of crude *Quillaja* saponin (unmodified) was coadministered with 0.4% regular pork insulin, a less significant reduction in glucose serum levels was obtained. *See* Figure 3C.

Figure 4 shows the effect of the ocular administration of a control solution of 0.1% pure saponin (without insulin) on the blood glucose levels of 3 male rats. As can be seen from the graph, no significant hypoglycemic effect could be observed in the absence of insulin.

Figure 5 depicts the results of the administration of 20 μl of 0.025% QA21-H and 0.4% regular pork insulin on the blood glucose levels of three rats. As can be seen from the graph, a significant hypoglycemic effect was observed.

Figure 6 shows a graph showing the results of the administration of 0.05% QA21-H and 0.4% regular pork insulin on the blood glucose levels of three male rats. As can be seen from the graph, a significant hypoglycemic effect was observed.

Figure 7 depicts a graph showing the results of the administration of 0.1% QA-21H and 0.4% regular pork insulin on the blood glucose levels of four male rats. As can be seen from the graph, a significant hypotensive effect was observed.

Figure 8 depicts a graph showing the blood lowering effect of the ocular administration of 10 μl/eye, 0.01% QA21-H and 0.4% regular pork insulin to a first rat; 10 μl/eye of 0.01% pure QA21-H and 0.4% regular pork insulin to a second rat; and 20 μl/eye of 0.01% QA21-H and 0.4% regular pork insulin to a third rat. The results show that even at 0.01 % QA-21H, some marginal transport of insulin was observed.

These experiments allow one to derive the following conclusions:

1. The effect of all the saponins tested on insulin absorption displayed a rapid onset, with maximal hypoglycemic action observed after 60 minutes.
2. Compared to Sigma saponin, Cambridge *Quillaja* saponin was less potent at stimulating systemic absorption of insulin from eye drops, whereas Cambridge QA 21-H was considerably more potent.

3. Ocular irritation decreased as the concentration of saponin decreased; 0.1% purified QA 21-H did cause ocular irritation, whiie 0.05% and 0.025% QA 21-H caused progressively less irritation; however the two lower non-irritating doses were ineffective in inducing transport, indicating that this product can be used effectively for transport in the absence of irritation. Partially purified (crude) *Quillaja* saponin also caused ocular irritation at 0.5%, a dose that was minimally effective in inducing transport, indicating that this crude product cannot be used effectively in absence of irritation.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention, and without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions, without undue experimentation.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A pharmaceutical composition for enhancing the uptake across mucous membranes of an animal of a pharmacologically active substance, wherein said pharmaceutical composition does not elicit an immune response, comprising

(a) ically modified saponin or fraction thereof obtainable from a crude *Quillaja saponaria* extract, wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is reduced to methylenealcohol or a methyleneamino group; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the fatty acid arabinose moiety or the fatty acid rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is reduced to methylenealcohol or a methyleneamino group and wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment;

(b) a pharmacologically active substance, and optionally

(c) a pharmaceutically acceptable carrier.

2. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA-17, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

3. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA-18, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

4. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA-21, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

5. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA-21-V1, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

6. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA-21-V2, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

7. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA-17 and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

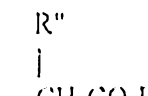
8. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA-18, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

9. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA-21, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

10. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA21-V1, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

11. The pharmaceutical composition of claim 1, wherein said saponin or fraction thereof is QA21-V2, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

12. The pharmaceutical composition of any one of claims 7-11, wherein said methyleneamino group is $-CH_2-N(R)-R'$, wherein R is hydrogen, R' is selected from the group consisting of hydrogen, C_{1-8} alkyl, C_2-C_{12} alkylaminoalkyl, allyl, aralkyl, C_3-C_6 cycloalkyl, aryl and a group having the formula



wherein R" is hydrogen, C_{1-3} alkyl, or C_{1-3} alkyl substituted by phenyl, hydroxyphenyl, indolyl, mercapto, C_{1-3} alkylthio, hydroxy, carboxy, amino, guanidino, imidazolyl or carbamyl; or wherein R and R" together form a pyrrolidinyl or piperidinyl ring.

13. A pharmaceutical composition for enhancing the uptake across mucous membranes of an animal of a pharmacologically active substance that does not elicit an immune response comprising

(a) chemically modified saponin or fraction thereof obtainable from a crude *Quillaja saponaria* extract, wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is reduced to methylenealcohol or a methyleneamino group and wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment;

(b) a pharmacologically active substance, and optionally;

(c) a pharmaceutically acceptable carrier.

14. The pharmaceutical composition of claim 13, wherein the said triterpene aldehyde group of said saponin or fraction thereof is reduced to methylenealcohol or a methyleneamino group.

15. The pharmaceutical composition of claim 13, wherein said saponin or fraction thereof is QA-18H, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

16. The pharmaceutical composition of claim 13, wherein said saponin or fraction thereof is QA-21H, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

17. The pharmaceutical composition of claim 13, wherein said saponin or fraction thereof is QA21-V1H, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

18. The pharmaceutical composition of claim 13, wherein said saponin or fraction thereof is QA21-V2H, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

19. The pharmaceutical composition of claim 13, wherein said saponin or fraction thereof is QA-18H, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

20. The pharmaceutical composition of claim 13, wherein said saponin or fraction thereof is QA-21H, and wherein said triterpene aldehyde group is reduced to a methyleneamino gr up.

21. The pharmaceutical composition of claim 13, wherein said saponin or fraction thereof is QA21-V1H, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

22. The pharmaceutical composition of claim 13, wherein said saponin or fraction thereof is QA-21-V2H, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

23. The pharmaceutical composition of any one of claims 19-22, wherein said methyleneamino group is $-CH_2-N(R)-R'$, wherein R is hydrogen; R' is selected from the group consisting of hydrogen, C_{1-8}alkyl, C_2-C_{12} alkylaminoalkyl, allyl, aralkyl, C_3-C_6 cycloalkyl, aryl and a group having the formula

$$\begin{array}{l} R'' \\ | \\ -CH-CO_2H, \end{array}$$

wherein R" is hydrogen, C_{1-4}alkyl, or C_{1-4}alkyl substituted by phenyl, hydroxyphenyl, indolyl, mercapto, C_{1-4} alkylthio, hydroxy, carboxy, amino, guanidino, imidazolyl or carbamyl; or wherein R and R" together form a pyrrolidinyl or piperidinyl ring.

24. A method for enhancing the uptake of a pharmacologically active substance, that does not elicit an immune response, across a mucous membrane of an animal, comprising contacting said mucous membrane with a pharmaceutical composition, comprising

(a) chemically modified saponin or fraction thereof obtainable from a crude *Quillaja saponaria* extract, wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is reduced to methylenealcohol or a methyleneamino group; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the fatty acid arabinose

moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is reduced to methylenealcohol or a methyleneamino group and wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment;

(b) a pharmacologically active substance, and optionally;

(c) a pharmaceutically acceptable carrier.

25. The method of claim 24, wherein said saponin or fraction thereof is QA-17, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

26. The method of claim 24, wherein said saponin or fraction thereof is QA-21, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

27. The method of claim 24, wherein said saponin or fraction thereof is QA-21-V1, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

28. The method of claim 24, wherein said saponin or fraction thereof is QA-21-V2, and wherein said triterpene aldehyde group is reduced to methylenealcohol.

29. The method of claim 24, wherein said saponin or fraction thereof is QA-17, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

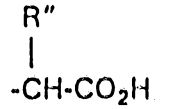
30. The method of claim 24, wherein said saponin or fraction thereof is QA-18, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

31. The method of claim 24, wherein said saponin or fraction thereof is QA-21, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

32. The method of claim 24, wherein said saponin or fraction thereof is QA-21-V1, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

33. The method of claim 24, wherein said saponin or fraction thereof is QA-21-V2, and wherein said triterpene aldehyde group is reduced to a methyleneamino group.

34. The method of any one of claims 29 33, wherein said methyleneamino group is $-CH_2-N(R)-R'$, wherein R is hydrogen; R' is selected from the group consisting of hydrogen, C_{1-8} alkyl, C_2-C_{12} alkylaminoalkyl, allyl, aralkyl, C_3-C_6 cycloalkyl, aryl and a group having the formula



wherein R" is hydrogen, C_{1-4}alkyl, or C_{1-4}alkyl substituted by phenyl, hydroxyphenyl, indolyl, mercapto, C_{1-4} alkylthio, hydroxy, carboxy, amino, guanidino, imidazolyl or carbamyl; or wherein R and R" together form a pyrrolidinyl or piperidinyl ring.

35. A method for enhancing the uptake of a pharmacologically active substance, that does not elicit an immune response, across a mucous membrane of an animal, comprising contacting said mucous membrane with a pharmaceutical composition, comprising

(a) chemically modified saponin or fraction thereof obtainable from a crude *Quillaja saponaria* extract, wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment; or wherein the chemically modified saponin or fraction thereof comprises at least one of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2, wherein the triterpene aldehyde group of QA-17, QA-18, QA-21, QA-21-V1 and QA21-V2 is reduced to methylenealcohol or a methyleneamino group and wherein the fatty acid arabinose moiety or the fatty acid arabinose-rhamnose moiety of QA-17, QA-18, QA-21, QA-21-V1 and QA-21-V2 is removed by hydrolysis to give the corresponding glycoside fragment;

(b) a pharmacologically active substance, and optionally;

(c) a pharmaceutically acceptable carrier.

36. The method of claim 35, wherein the triterpene aldehyde group of said chemically modified saponin or fraction thereof is reduced to methylenealcohol or a methyleneamino group.

37. The method of claim 35, wherein said aldehyde is reduced to a methyleneamino group having the formula $-CH_2-NH-R$, wherein R is selected from the group consisting of hydrogen, C_{1-8} alkyl, C_2-C_{12} alkylaminoalkyl, allyl, aralkyl, C_3-C_6 cycloalkyl, and aryl.

38. The method of claim 24 or 35, wherein said mucous membrane is present in the conjunctiva, nasopharynx, orthopharnyx, vagina, colon, urethra, urinary bladder or intestine.

39. The method of claim 24 or 35, wherein said pharmaceutical composition is contacted with said membrane by ocular administration to an animal.

40. The method of claim 24 or 35, wherein said pharmaceutical composition is contacted with said membrane by nasal administration to an animal.

41. The method of claim 24 or 35, wherein said pharmaceutical composition is contacted with said membrane by sublingual administration to an animal.

42. The method of claim 24 or 35, wherein said pharmaceutical composition is contacted with said membrane by vaginal administration to an animal.

43. The method of claim 24 or 35, wherein said pharmaceutical composition is contacted with said membrane by buccal administration to an animal.

44. The saponin QA-17 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-17, wherein the triterpene aldehyde group of the saponin QA 17 is reduced to methylenealcohol.

45.The saponin QA-.8 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-18, wherein the triterpene aldehyde group of the saponin QA-18 is reduced to methylenealcohol.

46. The saponin QA-18H or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-18H, wherein the triterpene aldehyde group of the saponin QA-18H is reduced to methylenealcohol.

47. The saponin QA-21 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-21, wherein the triterpene aldehyde group of the saponin QA-21 is reduced to methylenealcohol.

48. The saponin QA-21H or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-21H, wherein the triterpene aldehyde group of the saponin QA-21H is reduced to methylenealcohol.

49. The saponin QA21-V1 or a fraction obtainable from a crude *Quillaja saponaria* extract contai ing a saponin QA21-V1, wherein the triterpene aldehyde group of the saponin QA21-VI is reduced to methylenealcohol.

50. The saponin QA21-V2 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA21-V1, wherein the triterpene aldehyde group of the saponin QA21-V2 is reduced to methylenealcohol.

51. The saponin QA-17 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-17, wherein the triterpene aldehyde group of the saponin QA17 is reduced to a methyleneamino group

52. The saponin QA-18 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-18, wherein the triterpene aldehyde group of the saponin QA 18 is reduced to a methyleneamino group.

53. The saponin QA-18H or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-18H, wherein the triterpene aldehyde group of the saponin QA-18H is reduced to a methyleneamino group.

54. The saponin QA-21 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-21, wherein the triterpene aldehyde group of the saponin QA-21 is reduced to a methyleneamino group.

55. The saponin QA-21H or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA-21H, wherein the triterpene aldehyde group of the saponin QA-21H is reduced to a methyleneamino group.

56. The saponin QA21-V1 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA21-V1, wherein the triterpene aldehyde group of the saponin QA21-V1 is reduced to a methyleneamino group.

57. The saponin QA21-V2 or a fraction obtainable from a crude *Quillaja saponaria* extract containing a saponin QA21-V2, wherein the triterpene aldehyde group of the saponin AQ21-V2 is reduced to a methyleneamino group.

58. The saponin of any one of claims 51-57, wherein said methyleneamino group is $-CH_2-N(R)-R'$, wherein R is hydrogen; R' is selected from the group consisting of hydrogen, C_{1-8} alkyl, C_2-C_{12} alkylaminoalkyl, allyl, aralkyl, C_3-C_6 cycloalkyl, aryl and a group having the formula

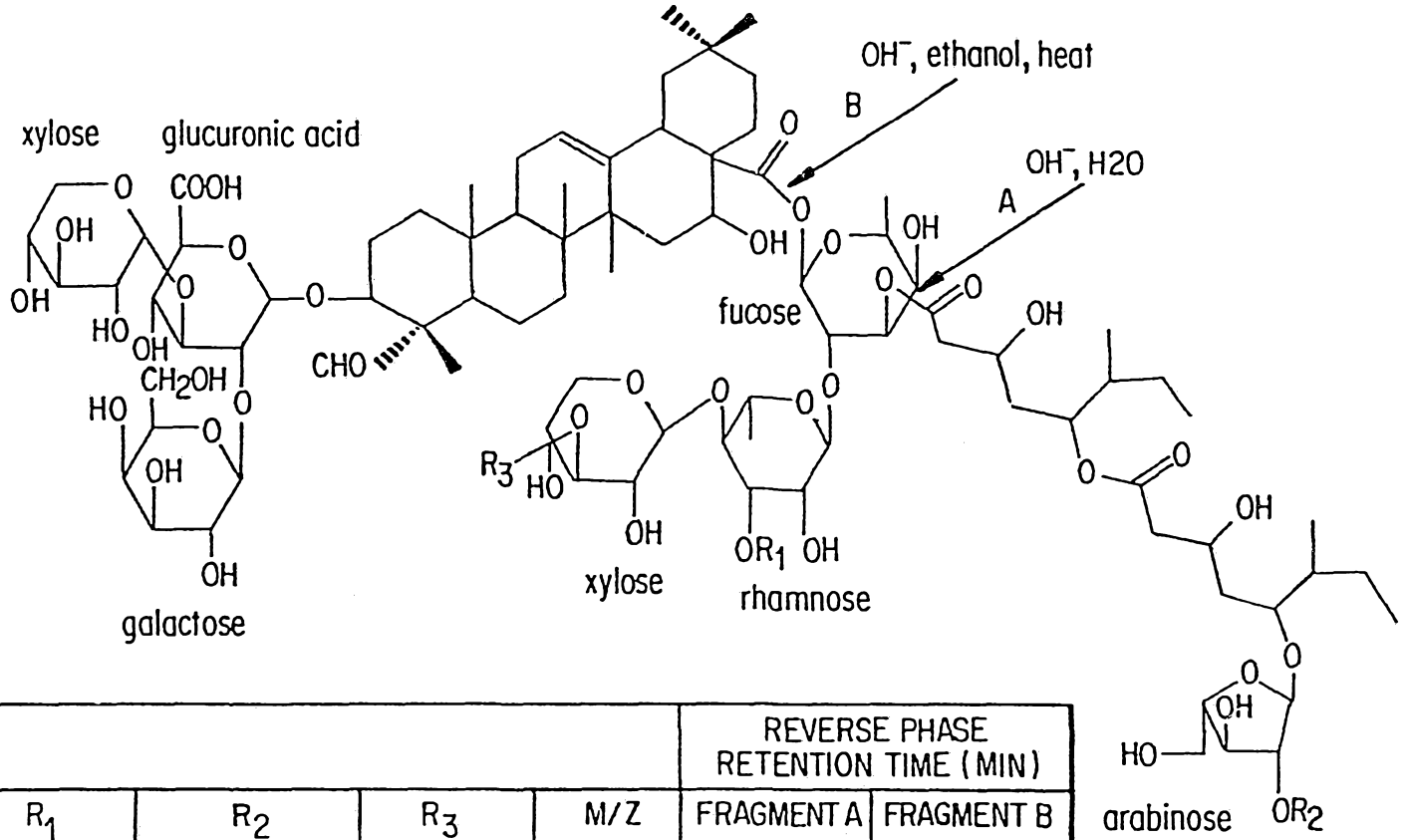


wherein R" is hydrogen, C_{1-4}alkyl, or C_{1-4}alkyl substituted by phenyl, hydroxyphenyl, indolyl, mercapto, C_{1-4} alkylthio, hydroxy, carboxy, amino, guanidino, imidazolyl or carbamyl; or wherein R and R" together form a pyrrolidinyl or piperidinyl ring.

Dated this 17 day of October 1997

CAMBRIDGE BIOTECH CORPORATION
Patent Attorneys for the Applicant
PETER MAXWELL & ASSOCIATES

SUBSTITUTE SHEET



					REVERSE PHASE RETENTION TIME (MIN)	
	R_1	R_2	R_3	M/Z	FRAGMENT A	FRAGMENT B
QA17	GLUCOSE	RHAMNOSE	APIOSE	2321	8.0	26.7
QA18	GLUCOSE	H	APIOSE	2174	8.0	26.4
QA21-V1	H	H	APIOSE	2012	9.3	25.6
QA21-V2	H	H	XYLOSE	2012	9.3	25.6

FIG. 1

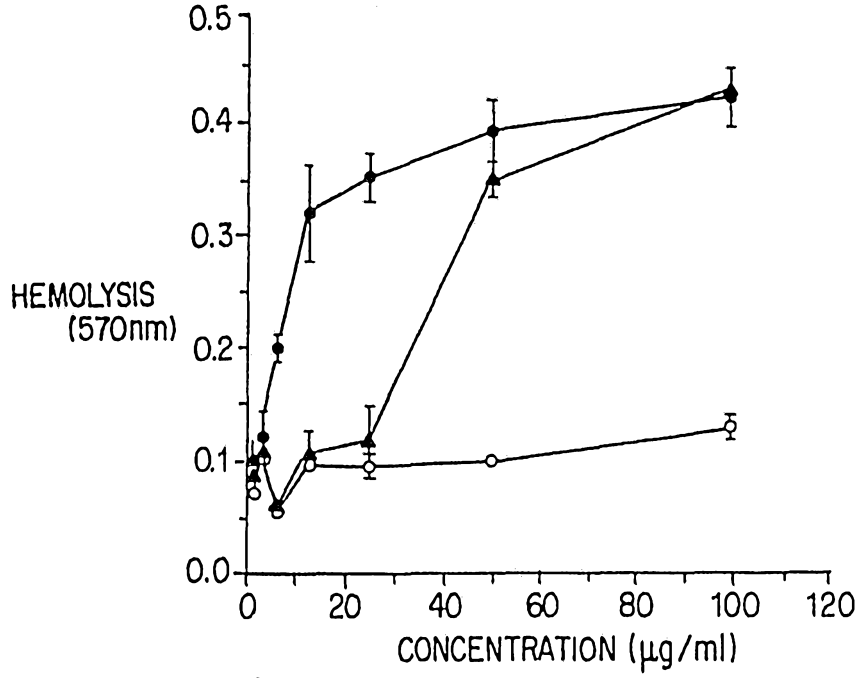

HEMOLYSIS
(570nm)
0.5
0.4
0.3
0.2
0.1
0.0
0
20
40
60
80
100
120
CONCENTRATION (µg/ml)

FIG. 2A

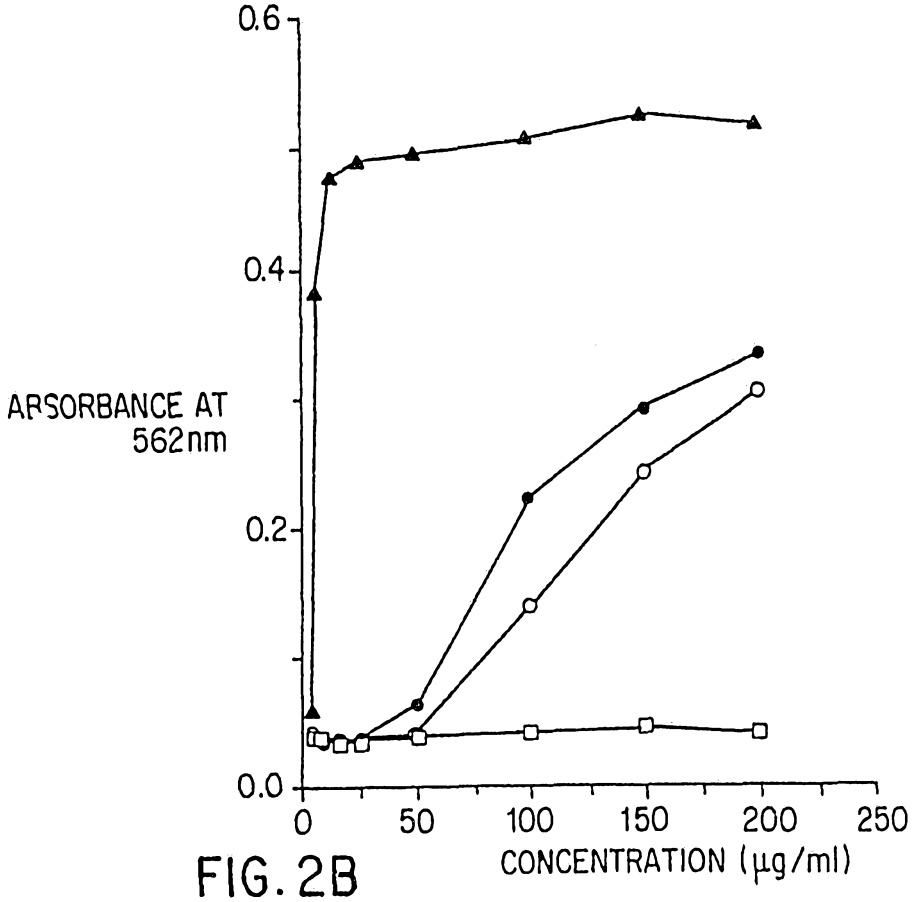

ARSORBANCE AT
562nm
0.6
0.4
0.2
0.0
0
50
100
150
200
250
CONCENTRATION (µg/ml)

FIG. 2B

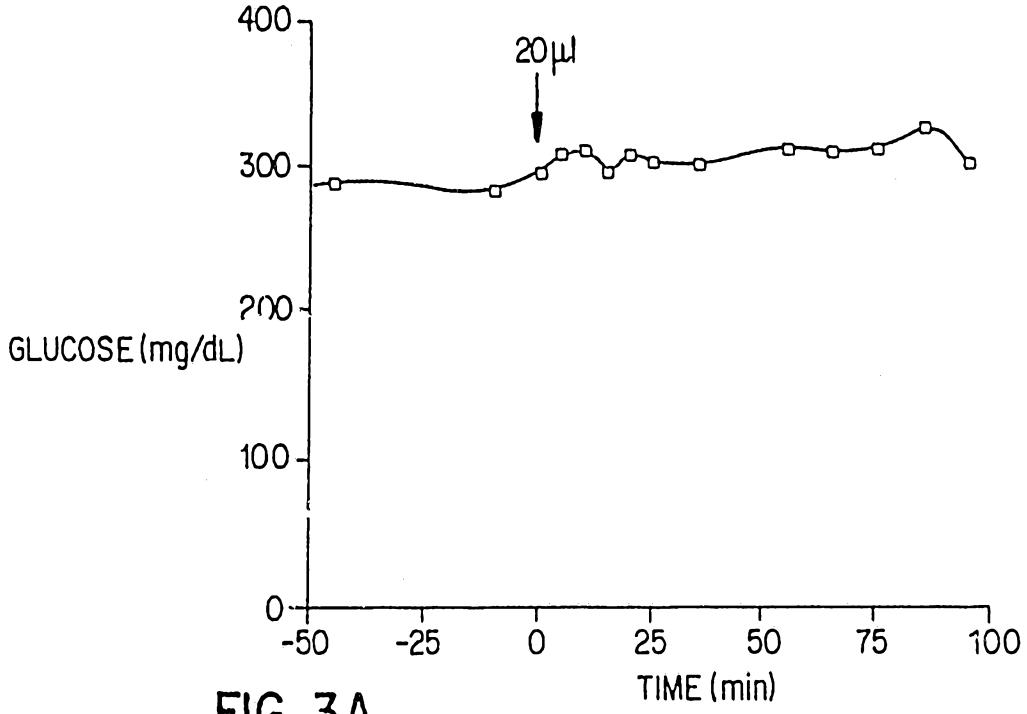

400
300
200
100
0
20µl
GLUCOSE (mg/dL)
-50
-25
0
25
50
75
100
TIME (min)

FIG. 3A

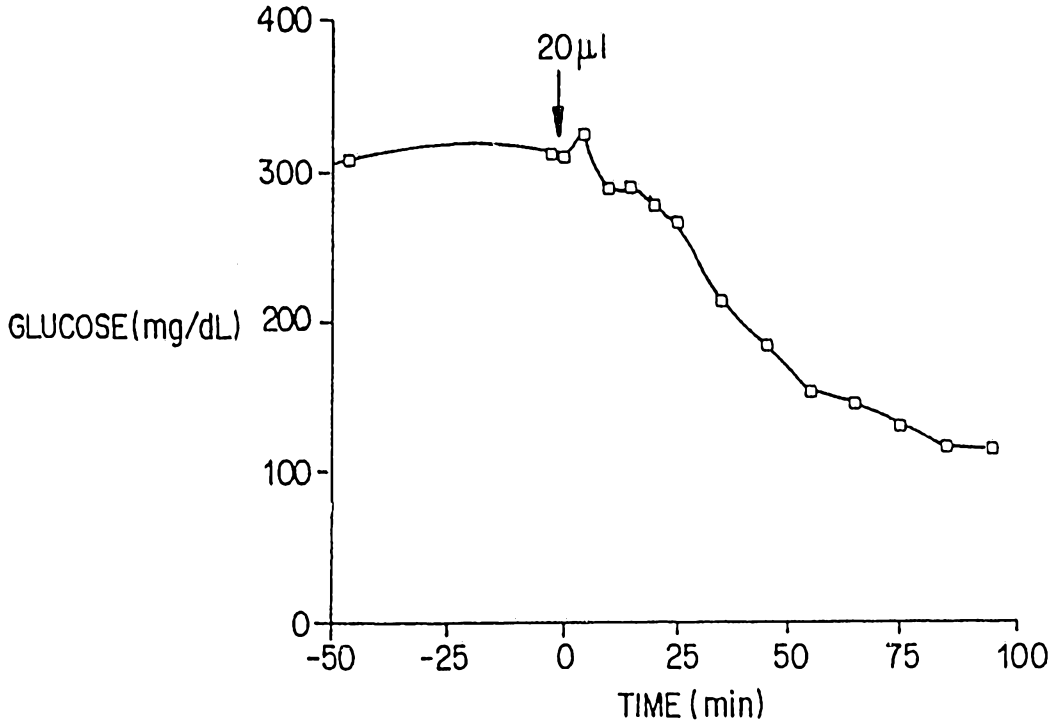

400
300
200
100
0
20µl
GLUCOSE (mg/dL)
-50
-25
0
25
50
75
100
TIME (min)

FIG. 3B

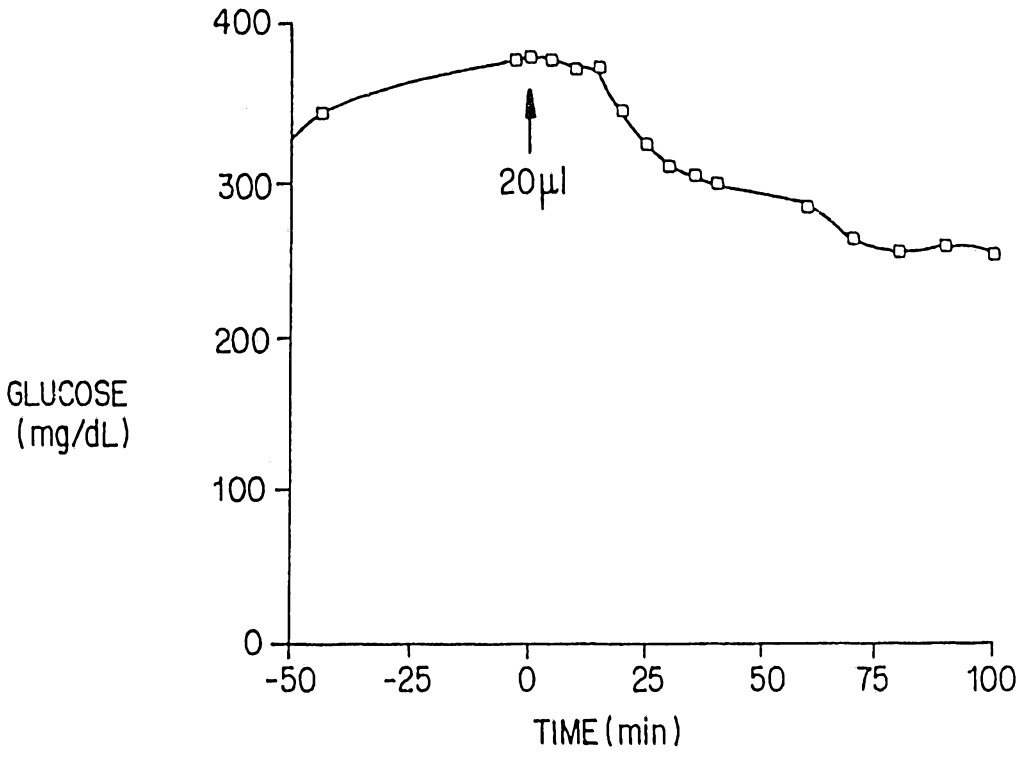


FIG. 3C

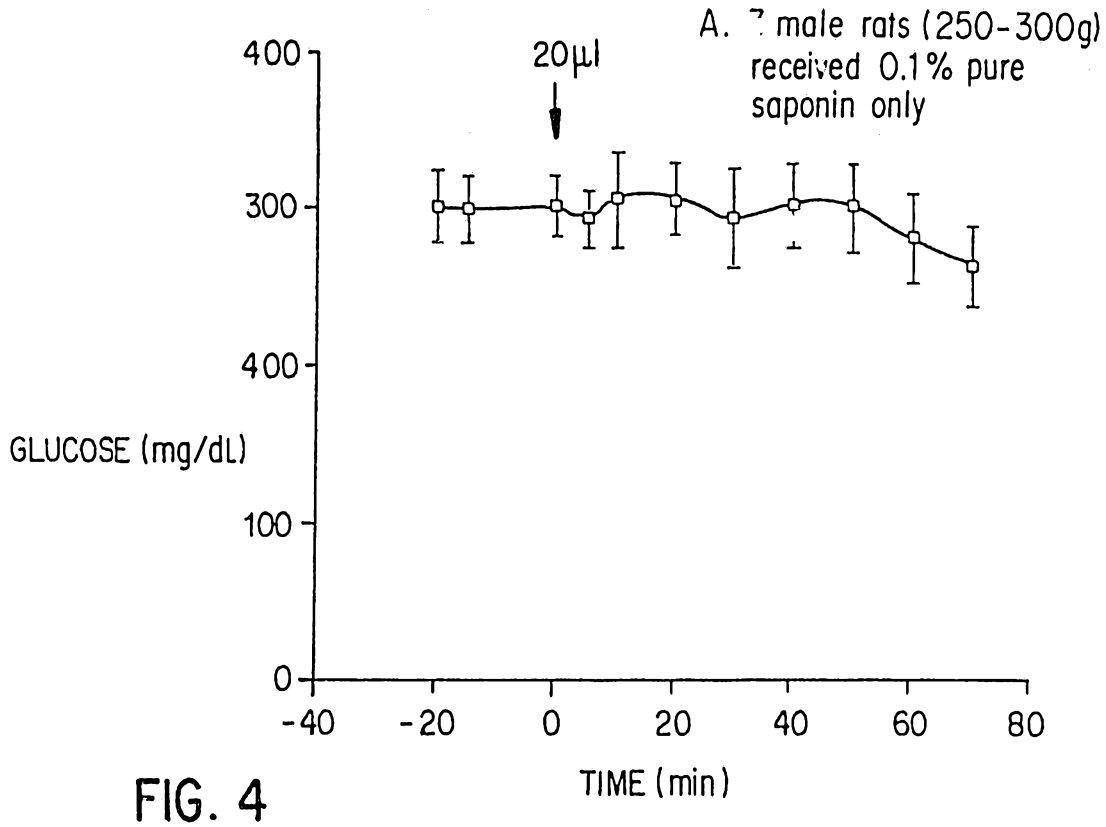

A. 7 male rats (250-300g) received 0.1% pure saponin only
20µl
400
300
400
100
0
GLUCOSE (mg/dL)
-40
-20
0
20
40
60
80
TIME (min)

FIG. 4

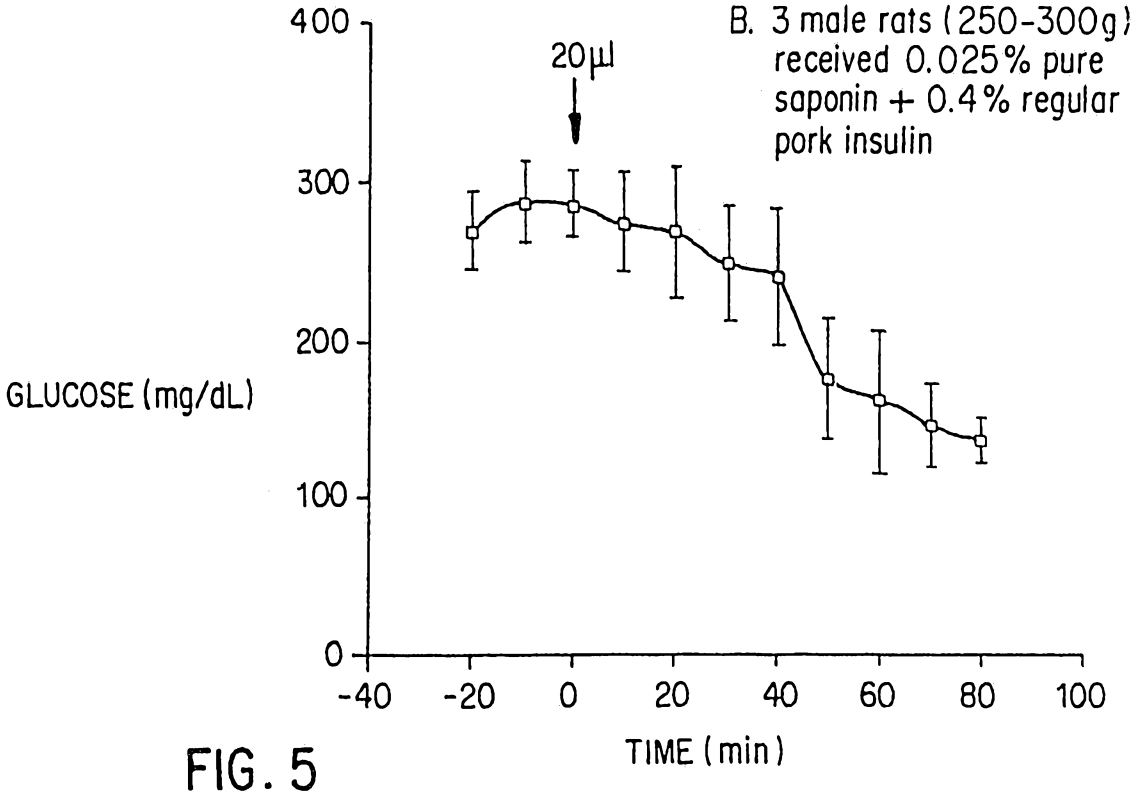

B. 3 male rats (250-300g) received 0.025% pure saponin + 0.4% regular pork insulin
20µl
400
300
200
100
0
GLUCOSE (mg/dL)
-40
-20
0
20
40
60
80
100
TIME (min)

FIG. 5

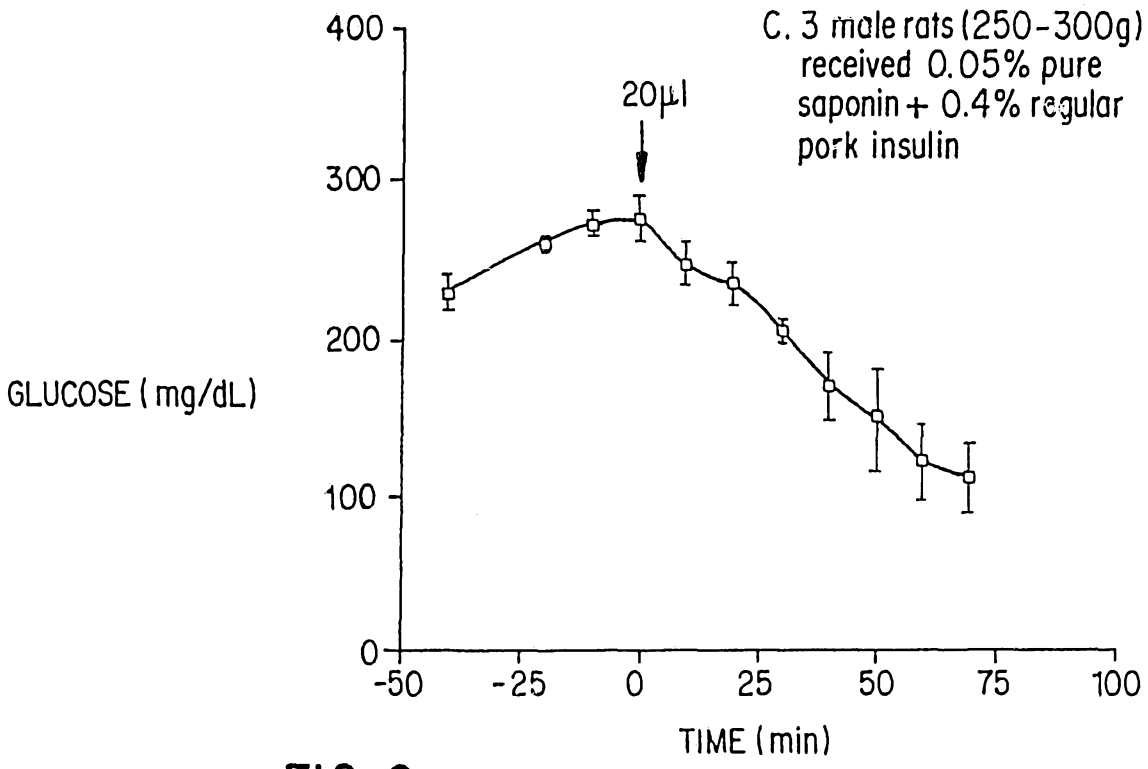

C. 3 male rats (250-300g) received 0.05% pure saponin + 0.4% regular pork insulin
20µl
GLUCOSE (mg/dL)
400
300
200
100
0
-50
-25
0
25
50
75
100
TIME (min)

FIG. 6

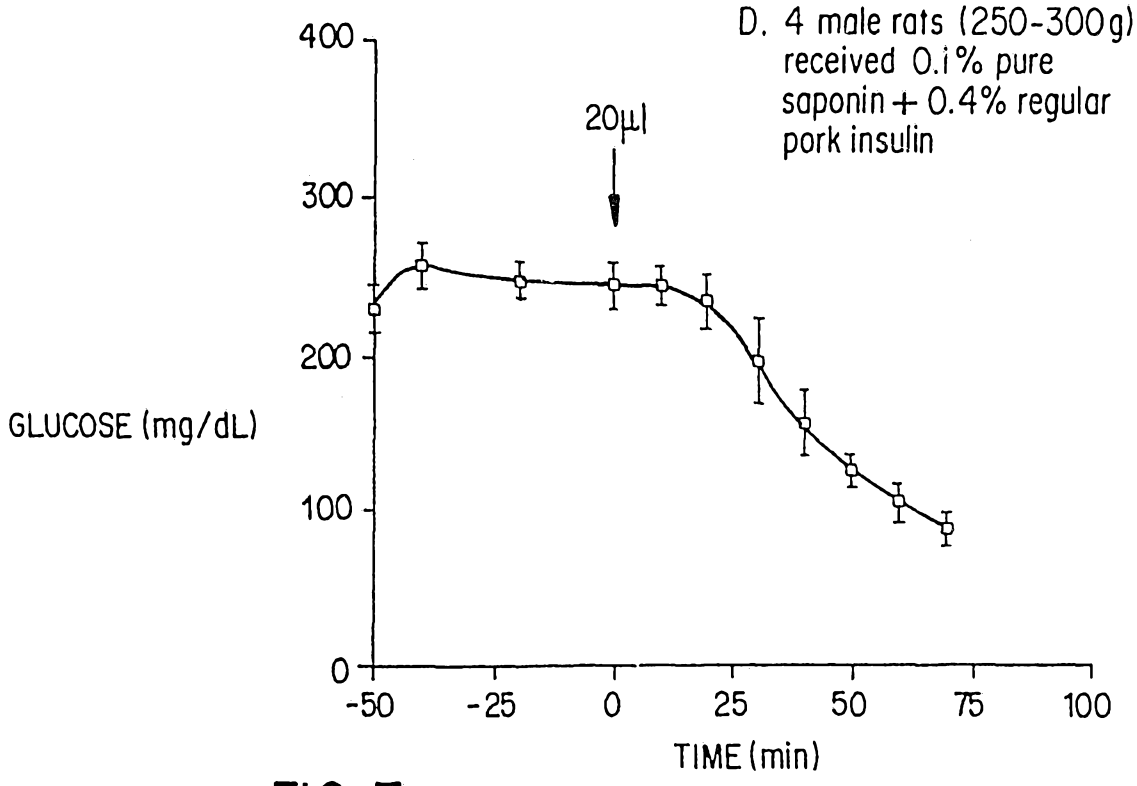
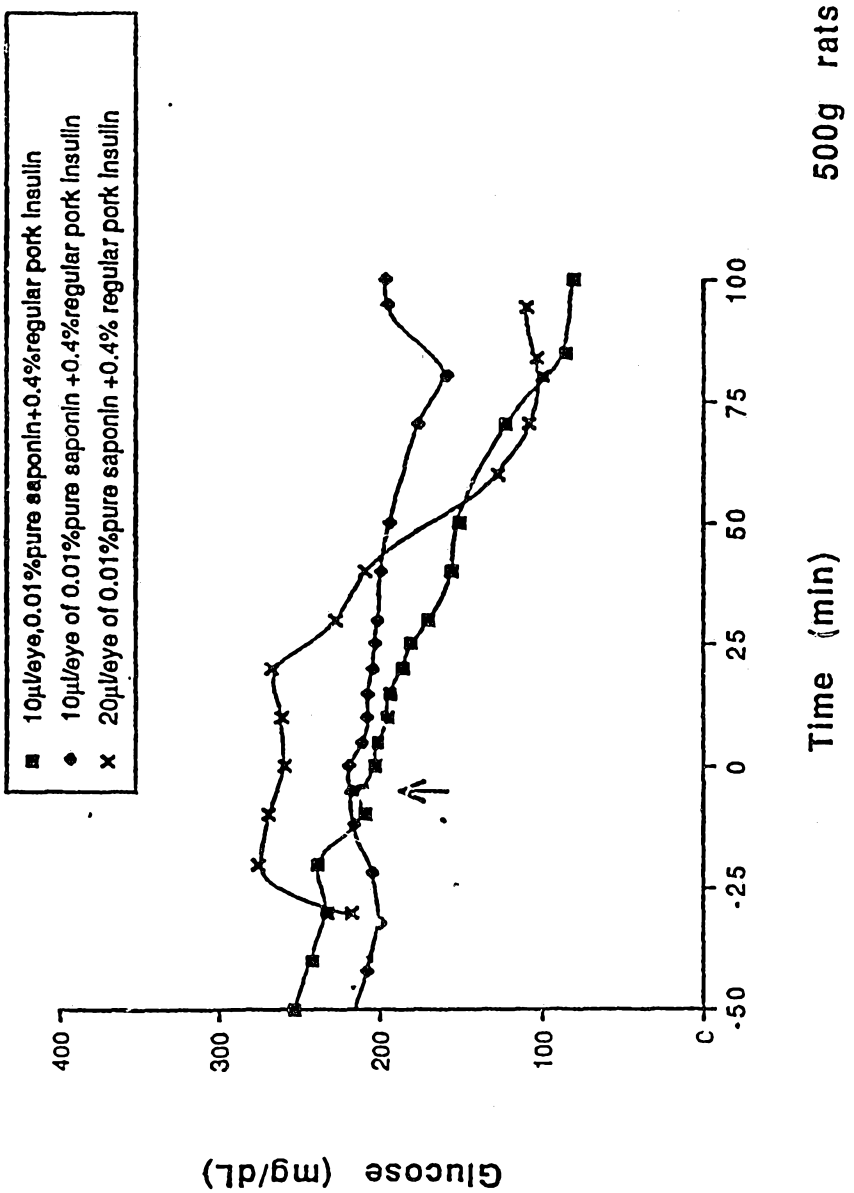

D. 4 male rats (250-300g) received 0.1% pure saponin + 0.4% regular pork insulin
20µl
GLUCOSE (mg/dL)
400
300
200
100
0
-50
-25
0
25
50
75
100
TIME (min)

FIG. 7

03 Rec'd PCT/PTO JUL 1994

FIGURE 8



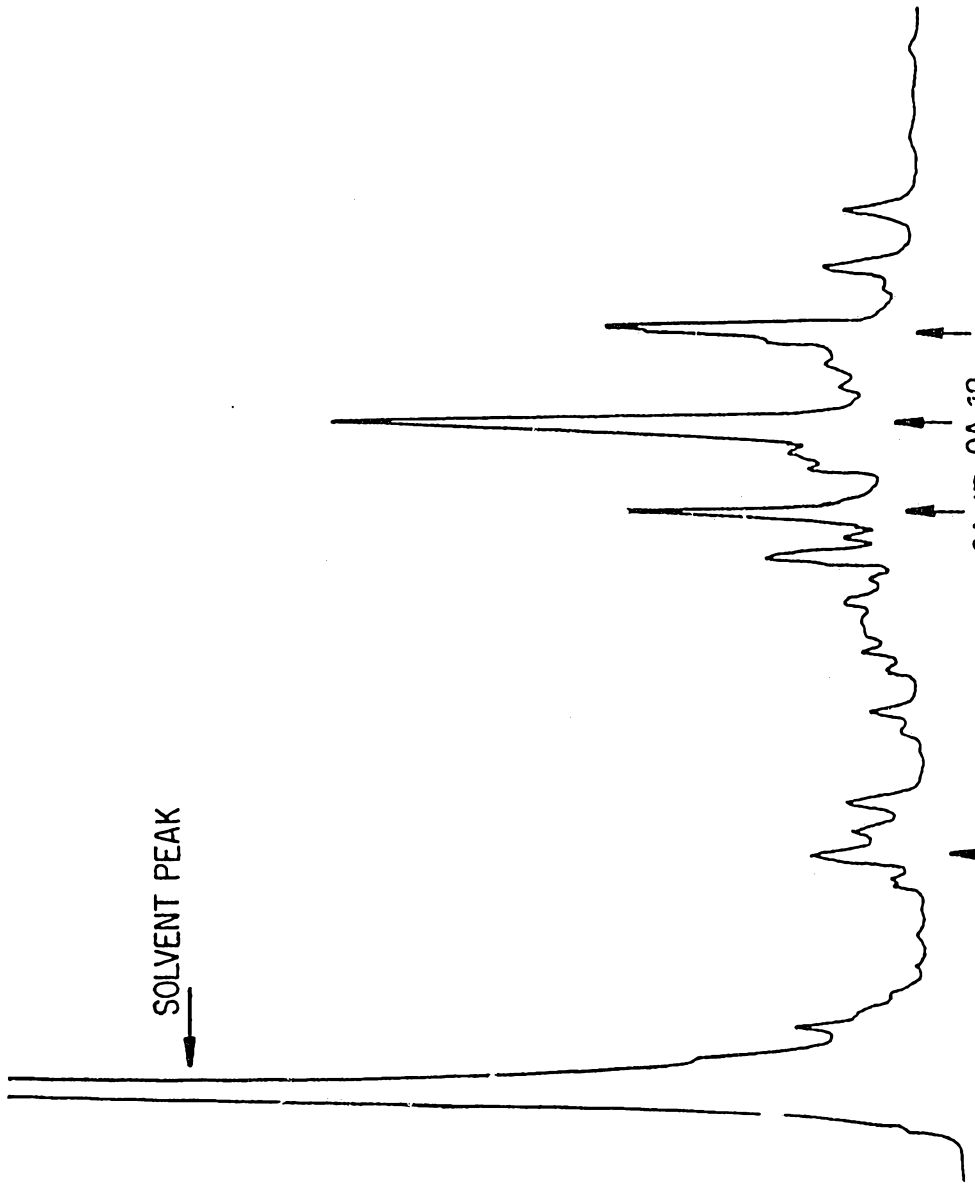

SOLVENT PEAK
QA-7
QA-17
QA-18
QA-21
RETENTION TIME
RELATIVE ABSORBANCE AT 214 NM

FIG. 9A

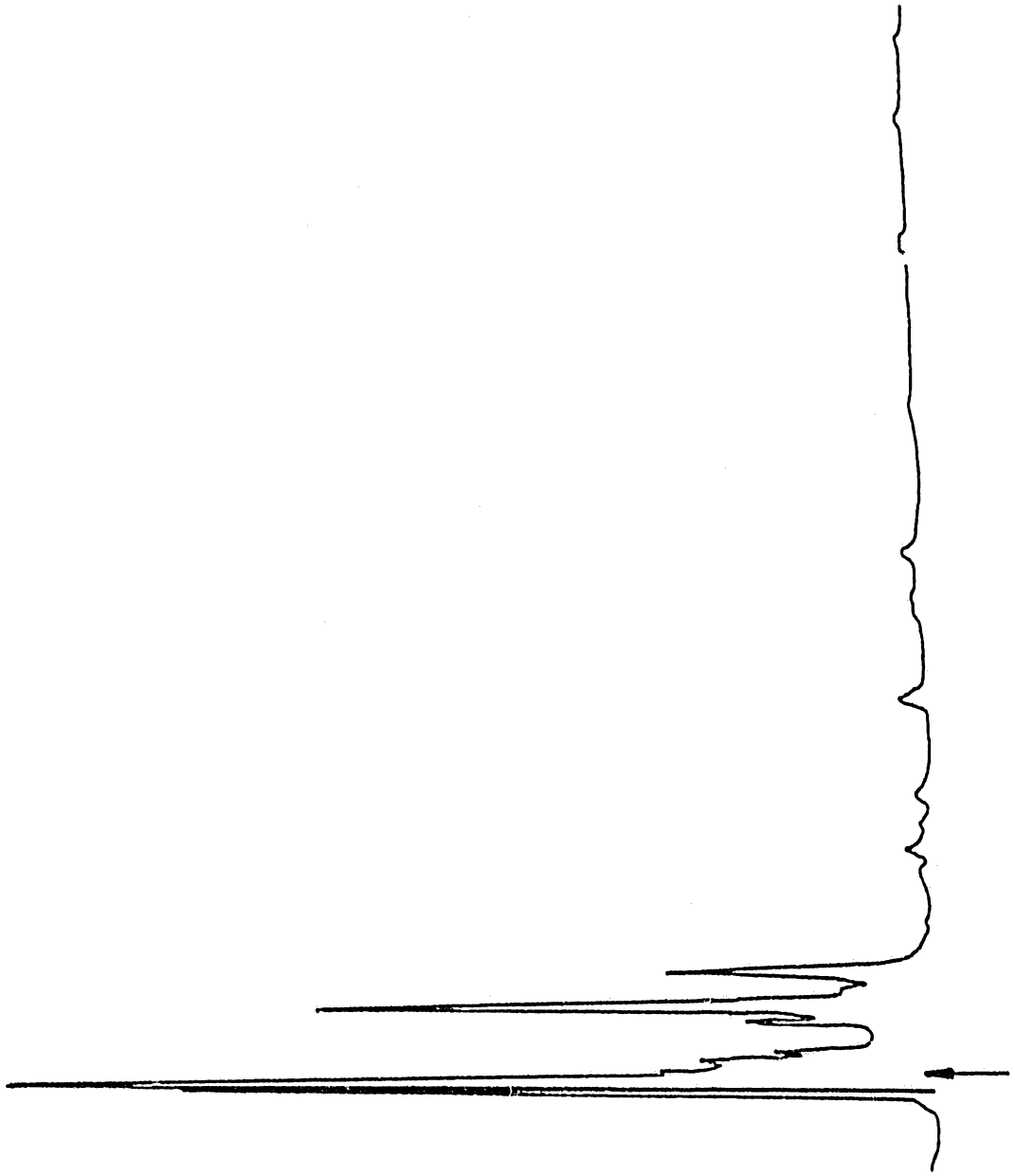


FIG. 9B

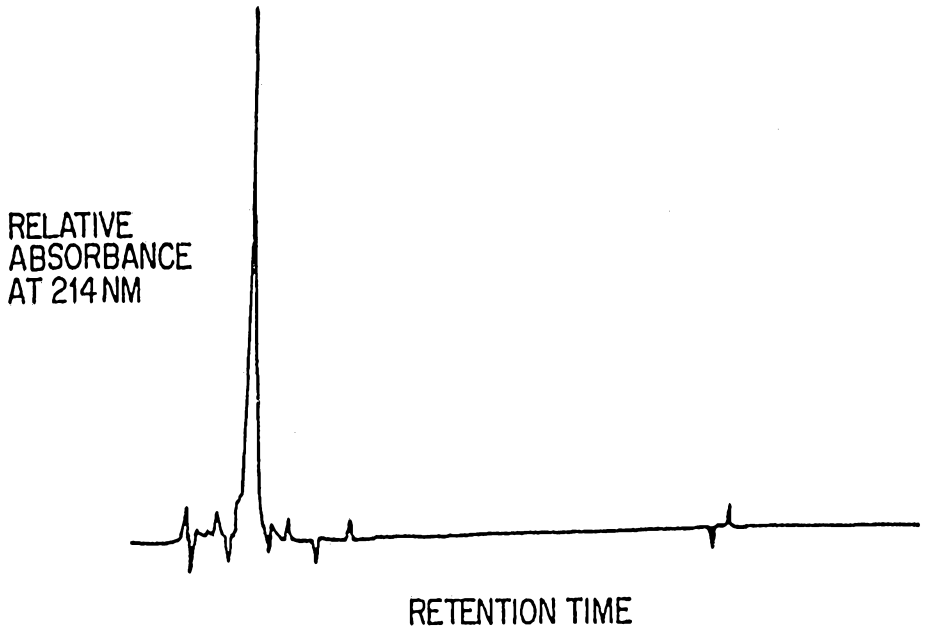


FIG. 10A

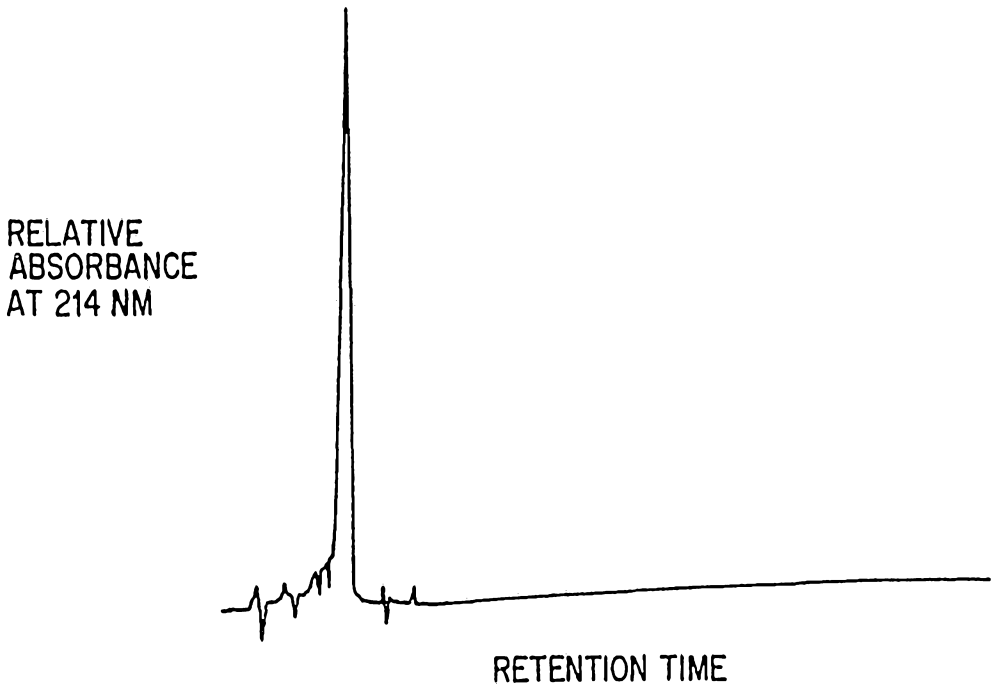


FIG. 10B

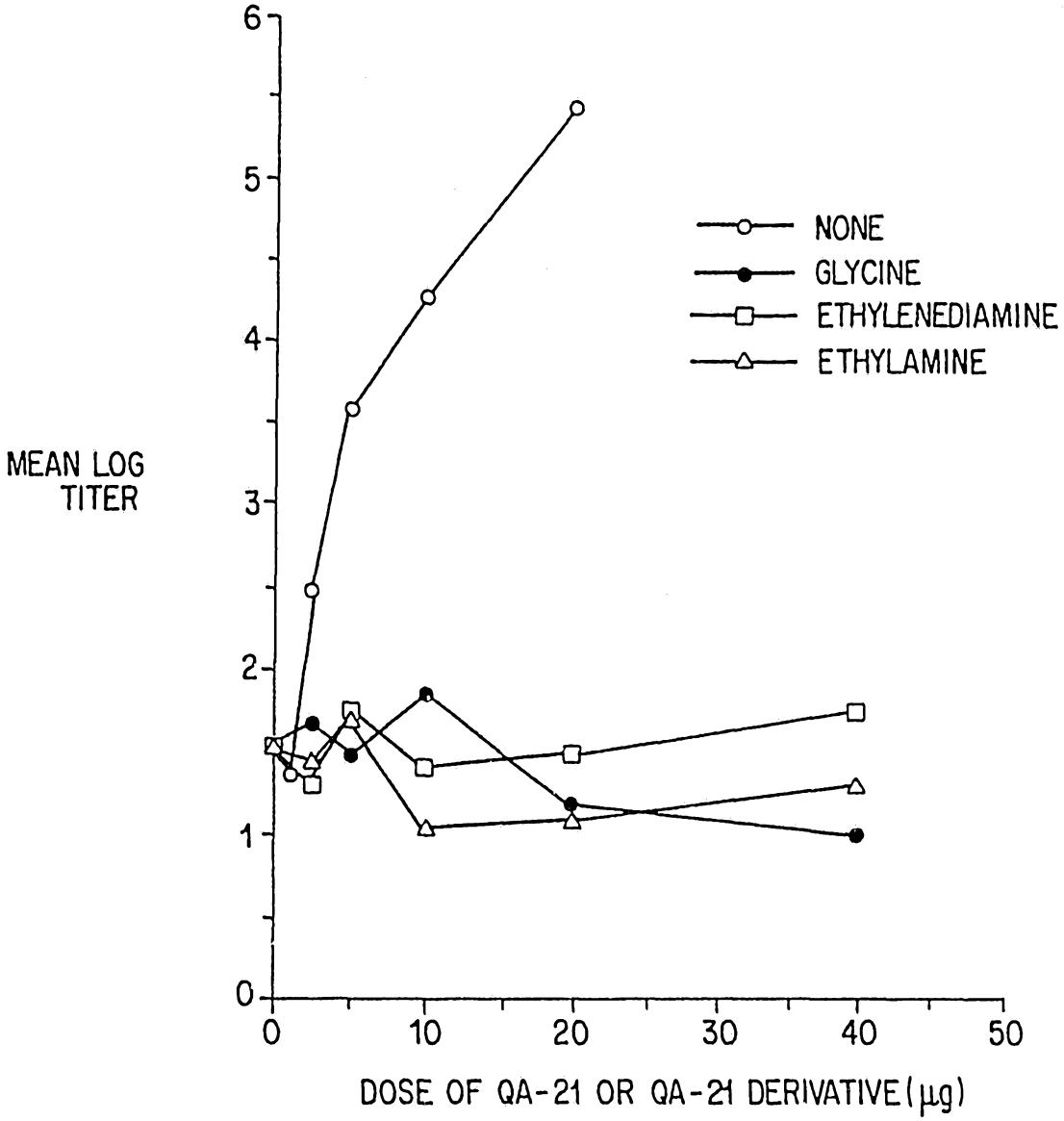

MEAN LOG TITER
6
5
4
3
2
1
0
0
10
20
30
40
50
DOSE OF QA-21 OR QA-21 DERIVATIVE (μg)
NONE
GLYCINE
ETHYLENEDIAMINE
ETHYLAMINE

FIG. 11

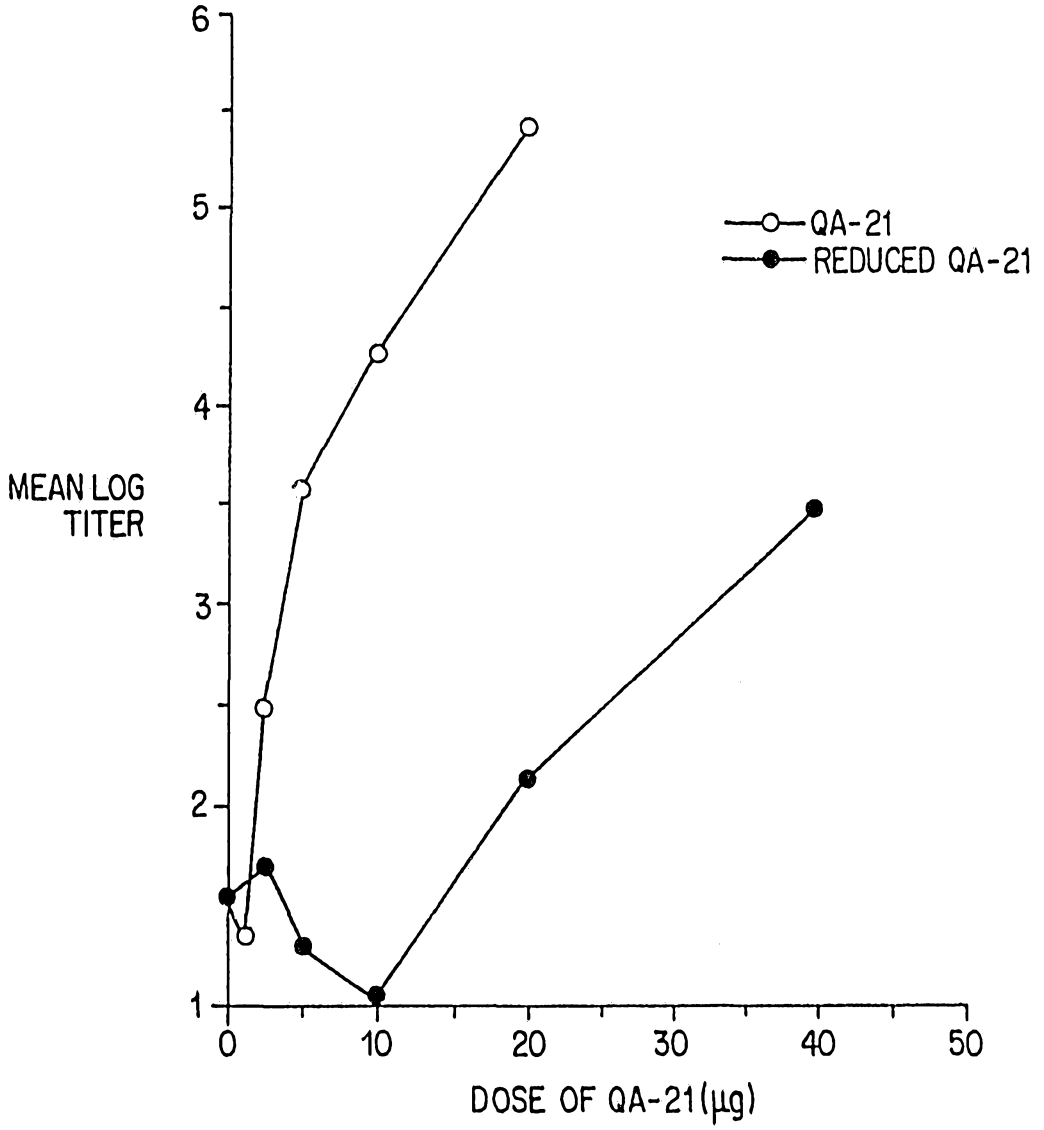

6
5
4
3
2
1
MEAN LOG TITER
QA-21
REDUCED QA-21
0
10
20
30
40
50
DOSE OF QA-21(μg)

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/06348

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :A61K 31/70, 31/705, 39/00

US CL :Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

cas online, Medline, APS, Biosis, CA, Cjacs, Inpadoc, Embase

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DD, A, 160,763 (Freidrich-Loeffler) 06 May 1978, abstract.	1-58
A	Veterinary Science Communications, Vol. 2, issued 1978, J.R. Egerton, et al., "Effect of Quil A, A Saponin Derivative, on the Response of Sheep to Alum Precipitated Bacteriodes Nodosus Vaccines," pages 247-252.	1-58

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search 26 August 1993	Date of mailing of the international search report 24SEP 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer KRISTIN LARSON Telephone No. (703) 308-0196

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/06348

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	Int. Archs. Allergy Appl. Immun., Vol. 67, issued 1982, R. Bomford, "Studies on the Cellular Site of Action of the Adjuvant Activity of Saponin for Sheep Erythrocytes," pages 127-131.	1-58
A	Int. Archs. Allergy Appl. Immun., Vol. 77, issued 1985, M.T. Scott, et al., "Adjuvant Activity of Saponin: Antigen Localization Studies," pages 409-412.	1-58
A	Archive fur die gesamte Virusforschung, Vol. 44, issued 1974, K. Dalsgaard, "Saponin Adjuvants," pages 243-254.	1-58
Y	Phytochemistry, Vol. 26, No. 1, issued 1987, R. Higuchi, et al., "Structure of Desacylsaponins Obtained from the Bark of Quillaja Saponaria," pages 229-235, see entire document.	44-58.
Y	Phytochemistry, Vol. 26, No. 8, issued 1987, R. Higuchi, et al., "Structure of Compounds Derived from the Acyl Moieties of Quillaja Saponin," pages 2357-2360, see entire document.	44-58.
A	Int. Archs. Allergy Appl. Immun., Vol. 63, issued 1980, R. Bomford, "Saponin and Other Haemolysins (Vitamin A, Aliphatic Amines, Polyene Antibiotics) as Adjuvants for SRBC in the Mouse," pages 170-177.	1-58
A	Immunology of Proteins and Peptides IV, issued 1991, A.C White, et al., "A purified Saponin Acts as an Adjuvant for a T-Independent Antigen," pages 207-210.	1-58
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International application No.
PCT/US93/06348

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Releva.. to claim No.
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X Y	The Journal of Immunology, Vol. 148, No. 5, issued 01 March 1992, J.Y. Wu, et al., "Saponin Adjuvant Enhancement of Antigen-Specific Immune Responses to an Experimental HIV-1 Vaccine," pages 1519-1525, see whole document.	54 55, 58
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/06348

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

514/25, 26, 33, 35; 424/88, 89, 195.1; 536/4.1, 5, 6.3, 18.1, 127, 128

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

514/25, 26, 33, 35, 885; 424/88, 89, 195.1; 536/4.1, 5, 6.3, 18.1, 127, 128