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International application number:	PCT/US2016/033271
International filing date:	19 May 2016 (19.05.2016)
Document type:	Certified copy of priority document
Document details:	Country/Office: US
	Number: 62/163,625
	Filing date: 19 May 2015 (19.05.2015)
Date of receipt at the International Bureau:	05 June 2016 (05.06.2016)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-bis)

784259

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APPLICATION NUMBER: 62/163,625

FILING DATE: May 19, 2015

RELATED PCT APPLICATION NUMBER: PCT/US16/33271

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US62/163,625



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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	4004.046USP1
		Application Number	
Title of Invention	ESSENTIAL OIL COMPOSITIONS AND APPLICATIONS UTILIZING ESSENTIAL OILS		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

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Prefix	Given Name	Middle Name	Family Name	Suffix		
	Richard	Dale	LAMB			
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City	Balaton	State/Province	MN	Country of Residence i	US	
Mailing Address of Inventor:						
Address 1	201 Washington Avenue North					
Address 2						
City	Balaton	State/Province	MN			
Postal Code	56115	Country i	US			
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Application Information:

Title of the Invention	ESSENTIAL OIL COMPOSITIONS AND APPLICATIONS UTILIZING ESSENTIAL OILS		
Attorney Docket Number	4004.046USP1	Small Entity Status Claimed	☒
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	Suggested Figure for Publication (if any)	

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Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

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☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. ☐ NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	4004.046USP1
		Application Number	
Title of Invention	ESSENTIAL OIL COMPOSITIONS AND APPLICATIONS UTILIZING ESSENTIAL OILS		

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Organization Name	Ralco Nutrition, Inc.
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Mailing Address Information:			
Address 1	1600 Hahn Road		
Address 2			
City	Marshall	State/Province	MN
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		Application Number	
Title of Invention	ESSENTIAL OIL COMPOSITIONS AND APPLICATIONS UTILIZING ESSENTIAL OILS		
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	4004.046USP1
		Application Number	
Title of Invention	ESSENTIAL OIL COMPOSITIONS AND APPLICATIONS UTILIZING ESSENTIAL OILS		

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ESSENTIAL OIL COMPOSITIONS AND APPLICATIONS UTILIZING ESSENTIAL OILS

BACKGROUND

[0001] Efficient rearing of livestock and other animals is dependent upon ensuring high growth rates, feed intake, productivity, and reproductive success. Some of the greatest threats to animal growth and productivity include bacterial and fungal infections, and oxidative stress. Hormones and antibiotics are commonly used to as productivity and growth promoters in animals. For example, antibiotics, such as coccidiostats, are often administered regularly in subtherapeutic doses to promote animal health and growth. However, these approaches have garnered significant outcry from scientific and social communities over the past decade.

[0002] Subtherapeutic antibiotics have been linked to pathogenic antibiotic resistance in animals and humans, and their use as animal feed additives and growth promoters are beginning to be banned in many countries. Similarly, animal hormonal supplements have been linked to detrimental side effects in animals as well as public health concerns for humans. Further, the need for alternatives to subtherapeutic antibiotics and hormonal growth promoters is readily recognized by the significant economic incentive to market animal products as “natural”, “organic”, “hormone-free” and “antibiotic-free”.

[0003] Essential oils such as oregano, thyme, and cinnamon have been disclosed in the art primarily as flavoring or odorizing agents. Essential oils have in some instances been disclosed as pharmaceuticals for medical and veterinary uses, yet the efficacy and compatibility of multi-essential oil blends are unpredictable and often undesirable. For example, U.S. Patent No.: 6,106,838 teaches that essential oils of thyme and oregano exhibit antagonist effects when combined for pharmaceutical uses.

SUMMARY

[0004] In general, embodiments of the present invention provide animal treatment compositions, and methods of making and using such products and compositions. The use of these products and compositions can act as nutritional and feed supplements to enhance the health and feed efficiency of animals.

[0005] Accordingly, embodiments of the present invention provide essential oil compositions comprising essential oils from oregano, thyme and cinnamon. Essential compositions can further include one or more emulsifiers and be in the form of an emulsion, wherein the average particle size of the composition is less than about 25 microns. Embodiments also relate to administering the composition to animals.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] **FIG. 1** illustrates a block flow diagram of a method of making an essential oil dispersion, according to one or more embodiments.

[0007] **FIG. 2** illustrates a block flow diagram of a method of treating a subject with an essential oil treatment composition, according to one or more embodiments.

[0008] **FIG. 3A** illustrates average daily gain data for broilers, according to one or more embodiments.

[0009] **FIG. 3B** illustrates average daily feed intake data for broilers, according to one or more embodiments.

[0010] **FIG. 3C** illustrates gain to feed data for broilers, according to one or more embodiments.

[0011] **FIG. 3D** illustrates feed to gain data for broilers, according to one or more embodiments.

[0012] **FIG. 3E** illustrates coefficient of variation data for broilers, according to one or more embodiments.

[0013] **FIG. 3F** illustrates mortality data for broilers, according to one or more embodiments.

[0014] **FIG. 4A** illustrates Cobb anticipated average daily gain data for representative broilers, according to one or more embodiments.

[0015] **FIG. 4B** illustrates Cobb anticipated average daily feed intake data for representative broilers, according to one or more embodiments.

[0016] **FIG. 4C** illustrates Cobb anticipated gain to feed data for representative broilers, according to one or more embodiments.

[0017] **FIG. 4D** illustrates Cobb anticipated feed to gain data for representative broilers, according to one or more embodiments.

DETAILED DESCRIPTION

[0018] This disclosure relates to essential oil compositions for use as animal supplement and feed compositions containing essential oils from oregano, thyme and cinnamon. These essential oil composition enhance the feed efficiency and health of animals, and additionally obviate the need for products such as hormonal and/or subtherapeutic antibiotic growth promoters.

[0019] As used herein, the recited terms have the following meanings. All other terms and phrases used in this specification have their ordinary meanings as one of skill in the art would understand after review of this disclosure.

[0020] As used herein, “plants” and “plant derivatives” can refer to any portion of a growing plant, including the roots, stems, stalks, leaves, branches, seeds, flowers, fruits, and the like. For example, cinnamon essential oil can be derived from the leaves or bark of a cinnamon plant.

[0021] As used herein, the term “essential oils” refers to aromatic, volatile liquids extracted from plant material. Essential oils are often concentrated hydrophobic liquids containing volatile aroma compounds. Essential oil chemical constituents can fall within general

classes, such as terpenes (e.g., p-Cymene, limonene, sabinene, α -pinene, γ -terpinene, β -caryophyllene), terpenoids (e.g., citronellal, thymol, carvacrol, carvone, borneol) and phenylpropanoids (e.g., cinnamaldehyde, eugenol, vanillin, safrole). Essential oils can be natural (i.e., derived from plants), or synthetic.

[0022] As used herein “cinnamon essential oil” refers to one or more of natural cinnamon oil (i.e., essential oil derived from plants in the *Cinnamomum* genus), or synthetic cinnamon oil. Synthetic cinnamon essential oil can comprise synthetic cinnamaldehyde. Synthetic cinnamon essential oil can further comprise one or more major constituents of natural cinnamon essential oil. A major constituent is one which comprises at least 1 wt.%, at least 2.5 wt.%, or at least 5 wt.% of a natural essential oil assay.

[0023] As used herein “thyme essential oil” refers to one or more of natural thyme oil (i.e., essential oil derived from plants in the *Thymus* genus), or synthetic thyme oil. Synthetic thyme essential oil can comprise synthetic thymol. Synthetic thyme essential oil can further comprise one or more major constituents of natural thyme essential oil.

[0024] As used herein “oregano essential oil” refers to one or more of natural oregano oil (i.e., essential oil derived from plants in the *Origanum* genus), or synthetic oregano oil. Synthetic oregano essential oil can comprise synthetic carvacrol. Synthetic oregano essential oil can further comprise one or more major constituents of natural oregano essential oil.

[0025] As used herein, the term “emulsion” refers to a fine dispersion of droplets of one liquid in which the liquid is not substantially soluble or miscible. An essential oil may be emulsified or substantially emulsified within an aqueous carrier, for example.

[0026] As used herein, the term “emulsifier” refers to a substance that stabilizes an emulsion. The emulsifier can physical, chemically or utilize both physical and chemical properties to interact with one or more substances of an emulsion. Tannic acid is an example of an emulsifier for essential oils and water.

[0027] As used herein, the term “tannin compound” refers to a polyphenolic biomolecule including at least twelve hydroxyl groups and at least five phenyl groups. Tannin compounds

include compounds utilizing gallic acid, flavone and phloroglucinol as base units. Tannic acid ($C_{76}H_{52}O_{46}$) is one form of a tannin compound. Tannic acid can include quercitannic acid and gallotannic acid, for example.

[0028] As used herein, “carrier” refers to a substance that physically binds or combines, or chemically binds or combines, with a target or active substance to facilitate the use, storage, or application of the target or active substance. Carriers are often inert materials, but can also include non-inert materials when compatible with the target or active substances. Examples of carriers include, but are not limited to, water for compositions that benefit from a liquid carrier, or diatomaceous earth for compositions that benefit from a solid carrier.

[0029] As used herein, “enzymes” refers to one or more biological molecules capable of breaking down cellulosic material. Enzymes include starch, proteins, non-starch polysaccharides, both soluble and insoluble, lignins and those biological molecules that facilitate chemical reactions within plants and animals.

[0030] As used herein, “poultry” refers to birds of the order Galliformes including ordinary domestic fowl or chicken (*Gallus domesticus*), turkeys (*Meleagris*), pheasants (*Phasianus*), partridges (*Perdix*), grouse (*Lagopus*), guinea fowl (*Numida*) peacocks (*Pavo*), and also birds of the order Anseriformes such as ducks (*Anas*) and geese (*Anser*).

[0031] In this disclosure, the novel utility of multi-essential oil compositions will be demonstrated. This disclosure relates to compositions including essential oils for enhancing feed efficiency and health of a subject. In many embodiments, subjects include animals. Enhancing feed efficiency can increase the growth rate, weight, weight gain rate, and nutrition of an animal. Enhanced health generally includes one or more of reduced or eliminated microbial infection, reduced or eliminated oxidative stress, reduced or eliminated infection or death during transport, reduced or eliminated microbial infection, increased body weight, increased rate of weight gain, increased growth rate, reduced or eliminated birth mortality, increased or improved body score conditions, increased reproductive success, and increased gut health maturation.

[0032] Reproductive success refers to general health outcomes and effects of both the mother and the young. Maturation of the gut can include developing indigenous microflora within the gut. Oxidative stress can include oxidative damage of tissues and cellular components, and is known to be a primary or secondary cause of many human diseases. In humans and animals, a variety of reactive oxygen species (ROS) are naturally produced through metabolic processes and by certain leukocyte populations during immune responses against disease.

[0033] Enhanced health can include various benefits specific to a certain class of animals. For example, enhanced health in poultry can include increased growth rate, feed efficiency, egg shell thickness and mortality rate. Enhanced health in dairy cows, or other milk-producing animals such as camels, goats, and sheep, can include increased milk production. In swine, for example, enhanced health can include a reduction or elimination of wasting diseases and mulberry heart. The essential oil compositions as provided herein can further be used as analogous or preferable substitutes for many commercial products used today, such as coccidiostats, subtherapeutic antibiotics, growth hormones, and other similar products. As such, a financial gain is realized by those selling milk, eggs, and meat products from animals consuming the compositions provided as the products can be more readily sold as “Natural”, “Organic”, “hormone-free”, and/or “Antibiotic-Free”.

[0034] Essential oil compositions as provided herein contain essential oils derived from plants (i.e., “natural” essential oils) and additionally or alternatively their synthetic analogues. Many embodiments comprise a combination of essential oils. Some embodiments comprise a combination of natural and synthetic essential oils. In some embodiments, synthetic essential oils can be a “nature’s equivalent” synthetic blend, which generally mimics an essential oil assay of a natural essential oil by including at least 5, at least 10, at least 15, or at least 20 of the most critical essential oils within a natural essential oil. A critical essential oil can be determined by weight percent, and/or by pharmacological efficacy. For example, a nature’s equivalent synthetic oil can comprise the following constitutions as provided in Table 1:

Table 1: Nature's Equivalent Synthetic Thyme Essential Oil:

Constituent	Wt. %
Thymol	42.7-44.08
para-Cymene	26.88-27.09
Linalool	4.3-4.34
alpha-Pinene	4.1-4.26
alpha-Terpineol	3.14-3.14
1,8-Cineole	2.82-3.01
beta-Caryophellene	1.98-2.27
Limonene	1.59-1.78
delta-3-Carene	1.3-1.41
beta-Myrcene	1.26-1.31
Linalyl Acetate	1.11-1.24
beta-Pinene	1.04-1.22
Terpinen-4-ol	0.96-1.14
alpha-Caryophyllene	0.71-0.71
gamma-Terpinene	0.7-0.7
Sabinene	0.37-0.5
Borneol	0.27-0.32
Camphene	0.13-0.17

[0035] The disclosure herein indicates the efficacy of compositions comprising a plurality of essential oils which provide a synergistic effect beyond essential oils utilized in isolation. Further, essential oil compositions provided herein do not exhibit antagonistic effect between essential oil moieties within a composition. An essential oil composition generally includes an essential oil fraction and one or more additional components. The ratio of the essential oil fraction to the one or more additional components in a composition can depend on several factors such as administration method, and the nutritional/health needs and/or palate of a consuming subject, among others. In many embodiments, a consuming subject comprises an animal. Compositions can comprise additional components including carriers, emulsifiers, and stabilizers, among others. Compositions as provided herein can be in the form of an emulsion.

[0036] The essential oils present in some embodiments can include oils from the classes of terpenes, terpenoids, phenylpropenes and combinations thereof. The essential oils present in some embodiments can include oils of plants from the Labiatae or Lamiaceae family, and the Lauraceae family, including hybrids of plants from one or both families. Suitable essential oils from the Lauraceae family can comprise those from the *Cinnamomum* genus. Within the *Cinnamomum* genus, suitable species can include *Cinnamomum burmannii*, *Cinnamomum cassia*, *Cinnamomum camphora*, *Cinnamomum loureiroi*, *Cinnamomum mercadoi*, *Cinnamomum oliveri*, *Cinnamomum osmophloeum*, *Cinnamomum ovalifolium*, *Cinnamomum parthenoxylon*, *Cinnamomum pedunculatum*, *Cinnamomum subavenium*, *Cinnamomum tamala*, *Cinnamomum verum*, *Cinnamomum verum*, and hybrids thereof.

[0037] Suitable essential oils from the Lamiaceae family can comprise those from one or more of the *Thymus* genus, the *Origanum* genus, the *Monarda* genus. Within the *Thymus* genus, a non-limiting list of suitable species can include *Thymus caespititius*, *Thymus capitatus*, *Thymus carnosus*, *Thymus citriodorus*, *Thymus glandulosus*, *Thymus Herba-borana*, *Thymus hyemalis*, *Thymus integer*, *Thymus pseudolanuginosus* (formerly *T. lanuginosus*), *Thymus mastichinia*, *Thymus montanus*, *Thymus moroderi*, *Thymus pannonicus*, *Thymus praecox*, *Thymus pulegioides*, *Thymus serpyllum*, *Thymus vulgaris*, *Thymus zygis*, and hybrids thereof. Within the *Origanum* genus, a non-limiting list of suitable species can include *Origanum amanum*, *Origanum compactum*, *cordifolium*, *Origanum dictamnus*, *Origanum laevigatum*, *Origanum libanoticum*, *Origanum majorana*, *Origanum microphyllum*, *Origanum onites*, *Origanum rotundifolium*, *Origanum scabrum*, *Origanum syriacum*, *Origanum vulgare*, and hybrids thereof. Within the *Monarda* genus, a non-limiting list of suitable species can include *Monarda citriodora*, *Monarda clinopodioides*, *Monarda didyma*, *Monarda fistulosa*, *Monarda media*, *Monarda punctata*, and hybrids thereof.

[0038] The essential oils present in some embodiments can further include lavender essential oils from the *Lavandula* genus, Mexican bay leaf essential oils from the *Liteas* genus (e.g., *L. glaucescens*), West Indian bay tree essential oils from the *Pimenta* genus (e.g., *P.*

racemosa), Indonesian bay leaf essential oils from the *Syzygium* genus, bay laurel essential oils from the *Laurus* genus (e.g., *L. nobilis*), California bay laurel essential oils from the *Umbellularia* genus (e.g., *U. californica*), lemon grass essential oils from the *Cymbopogon* genus (e.g., *C. ambiguous*, *C. citratus*, *C. flexuosus*, *C. martini*, *C. nardus*, *C. schoenanthus*), spearmint and peppermint essential oils from the *Mentha* genus (e.g., *M. spicata*, *M. piperita*), rosemary essential oils from the *Rosmarinus* genus (e.g., *R. officinalis*), sage essential oils from the *Salvia* genus (e.g., *S. sclarea*), hybrids thereof, and combinations thereof.

[0039] In some embodiments, an essential oil composition can include an essential oil fraction comprising three essential oils from the Lauraceae family and/or the Lamiaceae family. In some embodiments, an essential oil composition can include an essential oil fraction comprising cinnamon essential oil from the *Cinnamomum* genus, thyme essential oil from the *Thymus* genus, and oregano essential oil the *Origanum* genus. In some embodiments, an essential oil composition can include an essential oil fraction comprising synthetic cinnamaldehyde and thyme essential oils from the *Thymus* genus and oregano essential oil from the *Origanum* genus. In some embodiments, oregano essential oil can comprise carvacrol. Additionally or alternatively, thyme essential oil can comprise thymol.

[0040] In some embodiments, the essential oil fraction can comprise about 1% to about 49.5% oregano essential oil, about 1% to about 49.5% thyme essential oil, and about 1% to about 49.5% cinnamon essential oil. In other embodiments, the essential oil fraction can comprise about 5% to about 47.5% oregano essential oil, about 5% to about 47.5% thyme essential oil, and about 5% to about 47.5% cinnamon essential oil. In other embodiments, the essential oil fraction can comprise about 10% to about 45% oregano essential oil, about 10% to about 45% thyme essential oil, and about 10% to about 45% cinnamon essential oil. In other embodiments, the essential oil fraction can comprise about 15% to about 42.5% oregano essential oil, about 15% to about 42.5% thyme essential oil, and about 15% to about 42.5% cinnamon essential oil. In other embodiments, the essential oil fraction can comprise about 20% to about 40% oregano essential oil, about 20% to about 40% thyme essential oil, and about 20% to about 40% cinnamon

essential oil. In other embodiments, the essential oil fraction can comprise about 25% to about 37.5% oregano essential oil, about 25% to about 37.5% thyme essential oil, and about 25% to about 37.5% cinnamon essential oil. In other embodiments, the essential oil fraction can comprise about 30% to about 35% oregano essential oil, about 30% to about 35% thyme essential oil, and about 30% to about 35% cinnamon essential oil. In other embodiments, the essential oil fraction can comprise about 33.33% oregano essential oil, about 33.33% thyme essential oil, and about 33.33% cinnamon essential oil.

[0041] Many essential oil compositions comprise an essential oil fraction comprising an effective amount of carvacrol, an effective amount of thymol, and an effective amount of cinnamaldehyde. In an essential oil composition including an essential oil fraction comprising oregano essential oil, thyme essential oil, and cinnamon essential oil, the essential oil fraction can comprise three or more natural essential oils wherein the combined essential oils comprise at least an effective amount of carvacrol, at least an effective amount of thymol, and at least an effective amount of cinnamaldehyde. Suitable essential oils can include essential oils from the *Cinnamomum* genus, essential oils from the *Origanum* genus, essential oils from the *Thymus* genus, essential oils from the *Monarda* genus (e.g., *M. citriodora*, *M. clinopodioides*, *M. didyma*, *M. fistulosa*, *M. media*, *M. punctata*), essential oils from the *Trachyspermum* genus (e.g., *T. ammi*), essential oils from the *Nigella* genus (e.g., *N. sativa*), and combinations thereof. Other essential oils can be used such that effective amounts of carvacrol, thymol, and cinnamaldehyde are achieved in the essential oil fraction.

[0042] In an essential oil composition including an essential oil fraction comprising oregano essential oil, thyme essential oil, and synthetic cinnamaldehyde, the essential oil fraction can comprise two or more natural essential oils and synthetic cinnamaldehyde, wherein the combined essential oils and synthetic cinnamaldehyde comprise at an effective amount of carvacrol, at least an effective amount of thymol, and at least an effective amount of cinnamaldehyde. Suitable essential oils can include essential oils from the *Cinnamomum* genus, essential oils from the *Origanum* genus, essential oils from the *Thymus* genus, essential oils from

the *Monarda* genus (e.g., *M. didyma*, and *M. fistulosa*), essential oils from the *Trachyspermum* genus (e.g., *T. ammi*), essential oils from the *Nigella* genus (e.g., *N. sativa*), and combinations thereof. Still other natural essential oils can be used such that effective amounts of carvacrol, thymol, and cinnamaldehyde are achieved in the essential oil fraction.

[0043] Some essential oil compositions comprise an essential oil fraction comprising an effective amount of carvacrol, an effective amount of thymol, and an effective amount of cinnamaldehyde. An effective amount of carvacrol can comprise at least about 10 wt.%, at least about 15 wt.%, at least about 20 wt.%, at least about 25 wt.%, at least about 30 wt.%, or at least about 33 wt.% of the essential oil fraction. An effective amount of thymol can comprise at least about 10 wt.%, at least about 15 wt.%, at least about 20 wt.%, at least about 25 wt.%, at least about 30 wt.%, or at least about 33 wt.% of the essential oil fraction. An effective amount of cinnamaldehyde can comprise at least about 10 wt.%, at least about 15 wt.%, at least about 20 wt.%, at least about 25 wt.%, at least about 30 wt.%, or at least about 33 wt.% of the essential oil fraction. In some embodiments, oregano essential oil can be replaced by one or more oils which include at least 45 wt.% carvacrol, at least 55 wt.% carvacrol, at least 65 wt.% carvacrol, or at least 75 wt.% carvacrol. In some embodiments, thyme essential oil can be replaced by one or more oils which include at least 30 wt.% thymol, at least 35 wt.% thymol, at least 40 wt.% thymol, or at least 45 wt.% thymol. In some embodiments, cinnamon essential oil can be replaced by one or more oils which include at least 35 wt.% cinnamaldehyde, at least 40 wt.% cinnamaldehyde, at least 50 wt.% cinnamaldehyde, or at least 75 wt.% cinnamaldehyde. Suitable sources of effective amounts of carvacrol, thymol, and/or cinnamaldehyde can include natural essential oils and/or synthetic essential oils.

[0044] Essential oil compositions can further comprise one or more of an effective amount of paracymene, an effective amount of eugenol, or an effective amount of citronella. An effective amount of paracymene can comprise at least about 5 wt.%, at least about 7.5 wt.%, at least about 10 wt.%, or at least about 12.5 wt.% of the essential oil fraction. An effective amount of eugenol can comprise at least about 5 wt.%, at least about 7.5 wt.%, at least about 10 wt.%, or

at least about 12.5 wt.% of the essential oil fraction. An effective amount of citronella can comprise at least about 5 wt.%, at least about 7.5 wt.%, at least about 10 wt.%, or at least about 12.5 wt.% of the essential oil fraction.

[0045] In some embodiments, the essential oil fraction comprises 100% of the essential oil composition. An essential oil composition can further comprise a carrier. Carriers are ideally inert materials which do not react with the active components (i.e., the essential oil fraction) of the composition chemically, or bind the active components physically by adsorption or absorption. Liquid carriers include water, pure water, such as reverse osmosis water, milk, milk replacers, natural and/or commercial liquid feeds, or other liquids germane to animal dietary needs. Milk replacers can be formulated to generally mimic the content of milk. For example, a milk replace can have a composition similar to that shown in Table 2:

Table 2: Example Milk Replacer Formula

Crude Protein, minimum	22.50%
Lysine, minimum	1.60%
Crude Fat, minimum	16.50%
Crude Fiber, maximum	0.50%
Calcium, minimum	0.65%
Calcium, maximum	1.15%
Phosphorus, minimum	0.60%
Sodium, minimum	0.50%
Sodium, maximum	1.00%
Selenium, minimum	0.25 ppm
Zinc, minimum	50 ppm

The composition can be at least about 50% liquid carrier by weight, at least about 75% liquid carrier by weight, at least about 85% liquid carrier by weight, or at least about 90% liquid carrier. In some embodiments, the composition will be about 80% to about 99% liquid carrier, about

85% to about 98% liquid carrier, about 90% to about 95% liquid carrier, or about 91% to about 94% liquid carrier. In other embodiments, the composition can be about 60% liquid carrier to about 74% liquid carrier, about 63% liquid carrier to about 71% liquid carrier, about 66% liquid carrier to about 68% liquid carrier, or about 67% liquid carrier.

[0046] Solid carriers can include limestone, diatomaceous earth, and animal feed. Carriers such as limestone, diatomaceous earth, and the like, are useful pre-feed carriers in that they may be first combined with an essential oil fraction to facilitate transportation and/or subsequent combination of the essential oil composition with a dry carrier such as animal feed. Animal feed can include hay, straw, corn husks, wheat, oats, barley, seeds, commercial livestock feed, and the like. In some embodiments where an essential oil composition comprises an essential oil fraction and a pre-feed carrier, the ratio of pre-feed carrier to the essential oil fraction can be at least 10:1, at least 15:1, at least 17:1, at least 18:1, or at least 20:1. In some embodiments, where an essential oil composition comprises an essential oil fraction and a carrier, with or without a pre-feed carrier, the ratio of carrier to the essential oil fraction can be at least about 1,000:1, at least about 4,500:1, at least about 9,000:1, at least about 20,000:1, at least about 35,000:1, or at least about 50,000:1.

[0047] The total amount of carrier in a composition can be determined based on the dietary needs of an animal, the tolerance of an animal to essential oil fraction, and other factors. Tolerance can include one or more of an animal's palatability and gastrointestinal tolerance to an essential oil fraction.

[0048] An essential oil composition can further comprise one or more emulsifiers. An emulsified essential oil fraction can increase the efficacy of an essential oil composition when ingested by a subject, and can make essential oil compositions more palatable to animals which consume the compositions orally. An essential oil fraction can be combined with an emulsifier and a dry carrier, or alternatively an essential oil fraction can be combined with an emulsifier and a liquid carrier, as disclosed above, to form an emulsion. The emulsifier can be combined with an essential oil fraction in a ratio of about 3:1 to about 1:3, about 2:1 to about 1:2, about 1.5:1 to

about 1:1.5, or about 1:1. An essential oil composition comprising an essential oil fraction, a liquid carrier, and an emulsifier can have an average essential oil droplet size of less than about 25 microns, less than about 15 microns, less than about 10 microns or less than about 5 microns.

[0049] An emulsifier combined with a liquid carrier can generally be referred to as a liquid emulsifier. In some embodiments, an emulsion can comprise up to about 35%, up to about 40%, up to about 45%, or up to about 50% essential oil fraction and emulsifier, with the balance comprising a liquid carrier. In some embodiments, an emulsion can comprise less than about 20%, less than about 15%, less than about 10%, about 5%, or less than about 5% essential oil fraction and emulsifier, with the balance comprising a liquid carrier. In some embodiments, an emulsion can comprise about 40% to about 60%, or about 45% to about 55% essential oil fraction and emulsifier, with the balance comprising a liquid carrier. In some embodiments, an emulsion can comprise about 1% to about 10%, about 2.5% to about 7.5%, or about 5% essential oil fraction and emulsifier, with the balance comprising a liquid carrier. In many embodiments the liquid carrier is water. The liquid carrier content can vary depending on the amount and type of emulsifier.

[0050] A suitable emulsifier is larch arabinogalactan. Other suitable emulsifiers include polydextrose, chitin, psyllium, methyl-cellulose, hydrolyzed guar, guar, soy polysaccharide, oat bran, pectin, inulin, Fructooligosaccharides (FOS), xanthan gum, alginate, chemically modified cellulosic, Acacia, and gum Arabic. One or more emulsifiers can be used to form an emulsion. In some embodiments, one or more emulsifiers can additionally or alternatively be used as a stabilizer. Stabilizers can be used to alter the viscosity of an emulsion. Altering a viscosity can include maintaining a viscosity, increasing a viscosity, or decreasing a viscosity.

[0051] In some embodiments, a suitable emulsifier can include a tannin compound, such as tannic acid. Tannin can be used as an alternative to or in combination with the emulsifiers described above. In some embodiments, a liquid emulsifier can comprise about 100% tannic acid, about 80% to about 95% tannic acid, about 60% to about 85% tannic acid, about 40% to about 60% or about 1% to about 50% tannic acid, with the balance being a liquid carrier.

[0052] **Figure 1**, illustrates a block flow diagram of a method 100 of making an essential oil composition, such as an essential oil emulsification in an aqueous carrier, is shown, according to some embodiments. One or more liquid emulsifiers are agitated 102. The one or more liquid emulsifiers are contacted 104 with one or more essential oils, sufficient to create an emulsion. The emulsion is agitated 106 while monitoring at least an emulsion temperature.

[0053] The liquid emulsifier (i.e., water and one or more emulsifiers) is agitated 102 in a vessel, such as by stirring, for a time sufficient to produce visible motion on the surface of the one or more liquid emulsifiers. The visible motion can be from the approximate surface center to one or more surface edges, at the perimeter of the vessel, for example. The time taken to reach such visible motion depends on the type of liquid emulsifier and ratio of emulsifier to water (e.g., viscosity). Once a suitable motion is established at the surface of the liquid emulsifier, one or more essential oils are added (e.g., contacted 104). The agitation of the liquid continues and an emulsion begins to form on contact. The contact rate or addition rate should be slow enough to substantially prevent volatilization of the essential oils.

[0054] The agitation continues during the addition of the essential oils. The emulsion begins to form assuming the rate of essential oil addition is slow enough to prevent a high shear environment, adversely affecting the volatilization of the oils. Agitation 106 of the emulsion then continues until the emulsion temperature reaches about 100°F to about 110°F, about 103°F to about 108°F or about 104°F to about 107°F. As the emulsion forms, the viscosity increases. The method of agitation should be adjusted to compensate for the increase in viscosity. For example, if a stirring method is used, the stirrer or paddle should increase in force to maintain the same level of movement of the liquid as the emulsion thickens.

[0055] The final emulsion can have an average droplet size of less than about 25 microns, less than about 15 microns, less than about 10 microns or less than about 5 microns. The smaller droplet size allows for a more stable emulsion and one that previously could not be utilized for animal health or agricultural uses due to instability and high volatilization rates.

[0056] **Figure 2** illustrates a method 200 of treating a subject 230 to improve the health and/or feed efficiency of the subject, wherein the method comprises administering 220 an essential oil composition 210 to a subject. Administering 220 can include oral ingestion of the essential oil composition 210 as a feed or liquid, ingesting the essential oil composition in an encapsulated form, or applying the essential oil composition 210 topically. Pill-based or encapsulated administrations can be ideal for compositions which are not sufficiently palatable or an animal. However, administration via water or food-based carriers can be preferred for ease of administration.

[0057] A subject 230 can include all manner of animals, including poultry, horses, cows, pigs, and the like. The amount of essential oil composition administered to a subject 230 can depend on the species of the subject 230, the size of the subject 10, and the health status of a subject 230. For example, essential oil compositions can be administered regularly (i.e., daily) as a routine nutritional and health supplement, as an intervention (i.e., for several days or for the duration of a particular episode) in response to or in conjunction with increased stress, disease, birth, or other factors, or as a one-time administration during birth or a severe infection, disease, or injury. In some embodiments, essential oil compositions 210 can be administered 220 to a subject 230 as a routine feed, in a dose of about 0.1 mg of essential oil fraction to about 1 mg of essential oil fraction per kg of subject body weight, about 0.25 mg of essential oil fraction to about 0.75 mg of essential oil fraction per kg of subject body weight, or about 0.5 mg essential oil fraction per kg of subject body weight. In some embodiments, essential oil compositions 210 can be administered 220 to a subject 230 as an intervention in a dose of about 1.0 mg of essential oil fraction to about 10 mg of essential oil fraction per kg of subject body weight, about 2 mg of essential oil fraction to about 7 mg of essential oil fraction per kg of subject body weight, or about 3.5 mg essential oil fraction per kg of subject body weight. In some embodiments, essential oil compositions 210 can be administered 220 to a subject 230 as a one-time administration in a dose of about 10 mg of essential oil fraction to about 30 mg of essential oil fraction per kg of subject body weight, about 13 mg of essential oil fraction to about 24 mg of

essential oil fraction per kg of subject body weight, or about 17 mg essential oil fraction per kg of subject body weight.

[0058] The following Examples are intended to illustrate the above invention and should not be construed as to narrow its scope. One skilled in the art will readily recognize that the Examples suggest many other ways in which the invention could be practiced. It should be understood that numerous variations and modifications may be made while remaining within the scope of the invention.

EXAMPLE 1: Evaluation of Essential Oils in Broiler Diets

[0059] A trial was conducted to evaluate the effect of an essential oil composition in broiler chicken diets on growth performance, feed efficiency, and mortality. The birds were raised without stress or challenge imposed by the researchers (e.g., no heat stress, no detectable pathogen or bacterial infections, no pathogens and parasites introduced into feed, no excessive overcrowding in pens). The trial was conducted with 6 replications for each of 3 levels of feed containing an essential oil composition (SO1, containing thyme essential oil, oregano essential oil, and cinnamaldehyde) tested against a positive control feed containing an essential oil composition (Regano[®] EX, containing thyme essential oil and oregano essential oil), and a full negative control feed containing no essential oil. The feed formulations were as follows:

1. Negative Control: pure feed (no essential oil)
2. Positive Control: 1.0 lbs. of Regano[®] EX per 1 ton of feed
3. SO1 Low: 0.5 lbs. of SO1 per 1 ton of feed
4. SO1 Mid: 1.0 lbs. of SO1 per 1 ton of feed
5. SO1 High: 1.5 lbs. of SO1 per 1 ton of feed

[0060] Ralco commercial product Regano[®] EX, comprises 90 wt.% carrier (~74.5 wt.% limestone, 15% wt.% diatomaceous earth), 0.5% wt.% de-dusting agent, 2.5 wt.% RO water, 2.5 wt.% commercial product Larafed solids (Larch tree arabinogalactan), and 5 wt.% essential oil. The essential oils fraction comprises 20% thyme oil and 80% oregano oil, with a total assay of

about 60.4 wt.% carvacrol, about 10.8 wt.% thymol, about 9 wt.% para-cymene, about 18.9 wt.% other secondary thyme oil and oregano oil constituents. SO1 comprises about 90 wt.% carrier (74.5 wt.% limestone, 15% wt.% diatomaceous earth), 0.5% wt.% de-dusting agent (mineral oil), 2.5 wt.% RO water, 2.5 wt.% commercial product Larafeed solids (Larch tree arabinogalactan), and 5 wt.% essential oil. The essential oils fraction comprises 33.33 wt.% thyme oil, 33.33 wt.% oregano oil, and 33.33 wt.% synthetic cinnamaldehyde, with a total assay of about 23.8 wt.% carvacrol, about 16.4 wt.% thymol, about 11.2 wt.% para-cymene, about 33.3 wt.% cinnamaldehyde about 14.6 wt.% other secondary thyme oil and oregano oil constituents.

[0061] The trial was run over 42 days with 660 1-day-old Cobb 500 cockeral broilers. The birds were wing banded, weighed, and randomly allotted to pens in one of 7 boxes on the date of delivery. Each battery brooder had 4 levels with 4 pens per level. Each level measured 3 feet wide by 4 feet long by 2 feet tall, resulting in a density of 0.545 ft²/bird. The feeding schedule was as follows:

Days 0-16: 1.50 lbs. of feed per chick

Days 17-26: 2.50 lbs. of feed per chick

Days 27-36: 4.00 lbs. of feed per chick

Days 37-42: 2.50 lbs. of feed per chick

[0062] The trial was conducted in a randomized complete block design, and data was analyzed using PROC MIXED procedure of SAS. Least squares means were separated by Fisher's Least Significant Difference. Generally, if birds are not stressed during trials, very little difference will be observed between treatments, as to bird growth, feed intake, average daily gain, and other factors. It is worth noting, then, that even under the stress-free conditions of this trial, advantages of the SO1 formulations over the positive control (Regano[®] EX) and negative control were still observed. Particularly, the results indicate a synergistic effect of the three-oil SO1 formulation as compared to the two-oil Regano[®] EX formulation. Cobb data for anticipated performance of representative birds has been included to validate the trial design. Table 3

includes data for body weight, average daily gain, average daily feed intake, gain to feed, and feed to gain data for birds over the six week trial:

Table 3:

	Feed Treatment and Time					SEM	P - Value
	Control	Regano EX 1.0 lb	SO1 0.5 lb	SO1 1.0 lb	SO1 1.5 lb		
Number of pens	6	6	6	6	6		
Body Weights, g							
Initial	43.6	43.5	43.4	43.7	43.7	13.69	0.96
1st Week	161.5	161.1	162.8	162.0	163.2	13.69	
2nd Week	463.0	463.7	472.3	467.6	466.9	13.69	
3rd Week	970.2	966.8	972.3	968.1	966.2	13.69	
4th Week	1604.0	1593.3	1597.6	1583.5	1581.9	13.69	
5th Week	2273.0	2249.2	2271.9	2239.9	2224.5	13.69	
6th Week	2959.81	2913.29	2950.29	2939.04	2910.61	13.69	
Average	1210.7	1198.7	1210.1	1200.6	1193.9	5.18	0.10
ADG, g/d							
1st Week	16.58	16.73	16.80	16.83	17.16	1.71	0.93
2nd Week	42.54	42.81	43.07	43.38	43.56	1.71	
3rd Week	72.74	72.26	72.82	71.61	71.23	1.71	
4th Week	91.08	89.53	89.52	88.72	88.45	1.71	
5th Week	95.81	94.54	96.14	93.03	91.70	1.71	
6th Week	98.19	94.60	97.83	100.52	98.45	1.71	
Overall ADG	69.49	68.41	69.36	69.01	68.42	0.70	0.72
ADFI, g/d							
1st Week	29.89	29.61	30.06	28.57	28.71	3.18	0.81
2nd Week	58.05	56.04	58.38	58.07	58.58	3.18	
3rd Week	104.30	101.50	103.43	102.95	105.31	3.18	
4th Week	152.50	144.24	151.35	149.43	151.76	3.18	
5th Week	177.25	174.43	181.27	175.61	173.37	3.18	
6th Week	188.66	191.80	201.64	195.30	200.38	3.18	
Average	118.44	116.27	121.02	118.32	119.68	1.30	0.15
Gain to feed							
1st Week	0.56	0.57	0.56	0.59	0.60	0.02	0.71

2nd Week	0.73	0.77	0.74	0.75	0.74	0.02	
3rd Week	0.70	0.71	0.70	0.70	0.68	0.02	
4th Week	0.60	0.62	0.60	0.60	0.59	0.02	
5th Week	0.54	0.54	0.53	0.53	0.53	0.02	
6th Week	0.52	0.49	0.49	0.51	0.49	0.02	
Average	0.61	0.62	0.60	0.61	0.60	0.01	0.50
Feed to gain							
1st Week	1.81	1.77	1.79	1.70	1.68	0.05	0.76
2nd Week	1.37	1.31	1.36	1.34	1.35	0.05	
3rd Week	1.44	1.41	1.42	1.44	1.48	0.05	
4th Week	1.68	1.61	1.69	1.69	1.72	0.05	
5th Week	1.85	1.85	1.89	1.89	1.90	0.05	
6th Week	1.93	2.04	2.07	1.95	2.04	0.05	
Average	1.68	1.66	1.70	1.67	1.69	0.02	0.55

[0063] **Figure 3A** illustrates average daily gain data for broilers over the six trial weeks. Corresponding Cobb anticipated average daily gain data for representative broilers is illustrated in **Figure 4A**. Birds fed the SO1 Mid formulation exhibited the highest average daily gain in week 6. **Figure 3B** illustrates average daily feed intake data for broilers. Corresponding Cobb anticipated average daily feed intake data for representative broilers is illustrated in **Figure 4B**. Birds fed the SO1 Low, Mid, and High formulations all exhibited higher daily feed intakes in week 6 than birds fed either the negative or positive control. **Figure 3C** illustrates gain to feed data for broilers. Corresponding Cobb anticipated gain to feed data for representative broilers is illustrated in **Figure 4C**. Similarly, **Figure 3D** illustrates feed to gain data for broilers. Corresponding Cobb anticipated feed to gain data for representative broilers is illustrated in **Figure 4D**. **Figure 3E** illustrates coefficient of variation data for broilers. **Figure 3F** illustrates mortality data for broilers.

[0064] It can be seen from Figure 3A and Table 3 that the highest average daily gain was achieved in every week except week 4 by birds which were fed varying amounts of the SO1 formulation.

EXAMPLE 2: SO1 Diet Plan for Maximized Bird Health and Development

[0065] Strong development is critical in the early weeks of a bird's life, and accordingly a particularized feeding plan can be constructed to maximize bird health and development.

Using average daily gain data from Table 3 above, the following feeding plan can be implemented under the experimental conditions described in Example 1:

1st Week: SO1 High

2nd Week: SO1 High

3rd Week: SO1 Low

4th Week: SO1 Low

5th Week: SO1 Low

6th Week: SO1 Mid

EXAMPLE 3: ORAC for Essential Oil Compositions

[0066] Essential oil compositions as described herein can provide antioxidant properties to a host system and generally reduce oxidative stress in humans and animals. Oxygen radical absorbance capacity (ORAC) is the ability of a compound or composition to act as a proton donor and reducing agent for oxygen radicals. In particular, ORAC measures the ability of a compound or composition to act as a reducing agent for peroxy radicals, hydroxyl radicals, peroxynitrite, superoxide anion, and singlet oxygen, the five most damaging oxygen radicals. Table 4 illustrates the ORAC scores for oregano essential oil (*Origanum vulgare*), thyme essential oil (*Thymus vulgaris*), and cinnamon essential oil (*Cinnamomum zeylanicum*) against 5 of the most common detrimental oxygen species: peroxy radicals (RO_2), hydroxyl radicals ($\text{OH}^\cdot$), peroxynitrate (ONONO_2 ; $\text{H}_2\text{O}_2 + \text{NO}_2^\cdot$), superoxide anion ($\text{O}_2^{\cdot-}$), and singlet oxygen (O_2). Results are expressed as trolox equivalents (TE/100g) for each composition:

Table 4: ORAC Capabilities of Essential Oil Compositions

Oxygen species	Oxygen Radical Absorbance Capacity (TE/100g)			
	Origanum vulgare	Thymus vulgaris	Cinnamomum zeylanicum	Origanum, Thymus and Cinnamomum Blend
Peroxyl radical	510,800	386,000	18,800	305,200
Hydroxyl radical	1,046,900	896,700	49,300	664,300
Peroxynitrite	5100	4,300	3,500	4,300
Superoxide anion	0	0	978,900	326,300
Singlet oxygen	361,400	207,900	90,800	220,000
Total ORAC	1,924,200	1,494,900	1,141,300	1,520,100

WHAT IS CLAIMED IS

1. A composition for increasing the health and feed efficiency of an animal, the composition comprising: an essential oil fraction including oregano essential oil, thyme essential oil, cinnamon essential oil.
2. The composition of claim 1, wherein the essential oil fraction comprises about 10% to about 45% oregano essential oil, about 10% to about 45% thyme essential oil, and about 10% to about 45% cinnamon essential oil.
3. The composition of claim 1, wherein the oregano essential oil comprises oil derived from the *Origanum* genus.
4. The composition of claim 1, wherein the oregano essential oil comprises oil derived from one or more of *Origanum amanum*, *Origanum compactum*, *cordifolium*, *Origanum dictamnus*, *Origanum laevigatum*, *Origanum libanoticum*, *Origanum majorana*, *Origanum microphyllum*, *Origanum onites*, *Origanum rotundifolium*, *Origanum scabrum*, *Origanum syriacum*, *Origanum vulgare*, and combinations thereof.
5. The composition of claim 1, wherein the oregano essential oil comprises synthetic carvacrol.
6. The composition of claim 1, wherein the oregano essential oil comprises one or more natural essential oils which collectively comprise at least 45% carvacrol.
7. The composition of claim 1, wherein the thyme essential oil comprises oil derived from the *Thymus* genus.

8. The composition of claim 1, wherein the thyme essential oil comprises oil derived from *Thymus caespititius*, *Thymus capitatus*, *Thymus carnosus*, *Thymus citriodorus*, *Thymus glandulosus*, *Thymus Herba-borana*, *Thymus hyemalis*, *Thymus integer*, *Thymus pseudolanuginosus*, *Thymus mastichinia*, *Thymus montanus*, *Thymus moroderi*, *Thymus pannonicus*, *Thymus praecox*, *Thymus pulegioides*, *Thymus serpyllum*, *Thymus vulgaris*, *Thymus zygis*, and combinations thereof.
9. The composition of claim 1, wherein the oregano essential oil comprises synthetic thymol.
10. The composition of claim 1, wherein the oregano essential oil comprises one or more natural essential oils which collectively comprise at least 30% thymol.
11. The composition of claim 1, wherein the cinnamon essential oil comprises oil derived from the *Cinnamomum* genus.
12. The composition of claim 1, wherein the cinnamon essential oil comprises oil derived from *Cinnamomum burmannii*, *Cinnamomum cassia*, *Cinnamomum camphora*, *Cinnamomum loureiroi*, *Cinnamomum mercadoi*, *Cinnamomum oliveri*, *Cinnamomum osmophloeum*, *Cinnamomum ovalifolium*, *Cinnamomum parthenoxylon*, *Cinnamomum pedunculatum*, *Cinnamomum subavenium*, *Cinnamomum tamala*, *Cinnamomum verum*, *Cinnamomum verum*, and combinations thereof.
13. The composition of claim 1, wherein the cinnamon essential oil comprises synthetic cinnamaldehyde.
14. The composition of claim 1, wherein the cinnamon essential oil comprises one or more natural essential oils which collectively comprise at least 35% cinnamaldehyde.

15. The composition of claim 1, wherein the essential oil fraction comprises three or more natural essential oils wherein the combined essential oils comprise at least 20% carvacrol, at least 15% thymol, and at least 30% cinnamaldehyde.
16. The composition of claim 1, wherein the essential oil fraction comprises two or more natural essential oils and synthetic cinnamaldehyde, wherein the combined essential oils and synthetic cinnamaldehyde comprise at least 20% carvacrol, at least 15% thymol, and at least 30% cinnamaldehyde.
17. The composition of claim 1, further comprising a carrier.
18. The composition of claim 1, further comprising an emulsifier.
19. The composition of claim 18, wherein the essential oil fraction is present as an emulsion.
20. The composition of claim 19, wherein the average droplet size of the essential oil fraction emulsion is less than about 25 microns.
21. The composition of claim 18, wherein the emulsifier comprises arabinogalactan.
22. A method of enhancing the health and feed efficiency of an animal, the method comprising:
administering an essential oil composition to an animal, wherein the essential oil composition comprises an essential oil fraction including oregano essential oil, thyme essential oil, cinnamon essential oil.
23. The method of claim 22, wherein the composition further comprises a carrier.

24. The method of claim 22, wherein the composition further comprises an emulsifier, and optionally a liquid carrier.
25. The method of claim 22, wherein the essential oil fraction is present as an emulsion.
26. The method of claim 25, wherein the average droplet size of the essential oil fraction emulsion is less than about 25 microns.
27. The method of claim 24, wherein the emulsifier comprises arabinogalactan.
28. The method of claim 24, wherein administering comprises one or more of oral administration or topical administration.
29. The method of claim 28, wherein oral administration can comprise ingesting the essential oil composition in one or more of a liquid form, in a solid feed form, or in an encapsulated form.

ABSTRACT

In general, embodiments of the present invention essential oil animal treatment compositions, and methods of making and using such products and compositions. The compositions comprise an essential oil fraction include including oregano essential oil, thyme essential oil, and cinnamon essential oil. The compositions can optionally include one or more emulsifiers and be in the form of an emulsion. The use of these products and compositions can enhance the health and feed efficiency of animals.

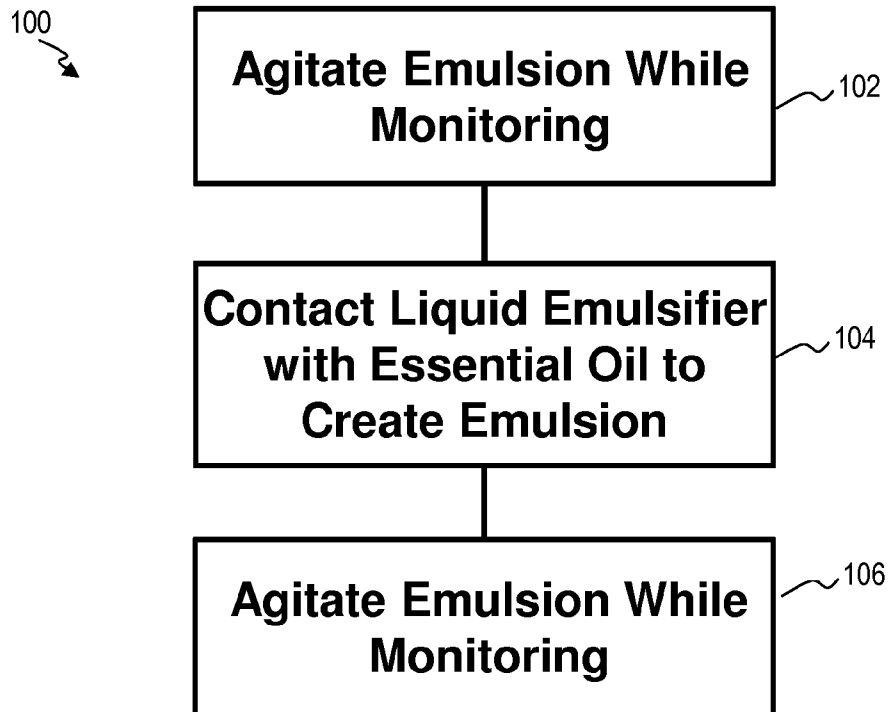


FIG 1

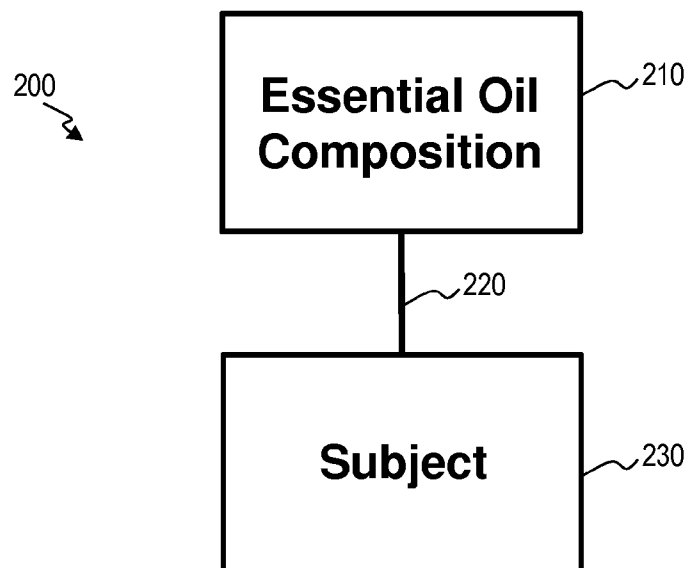


FIG 2

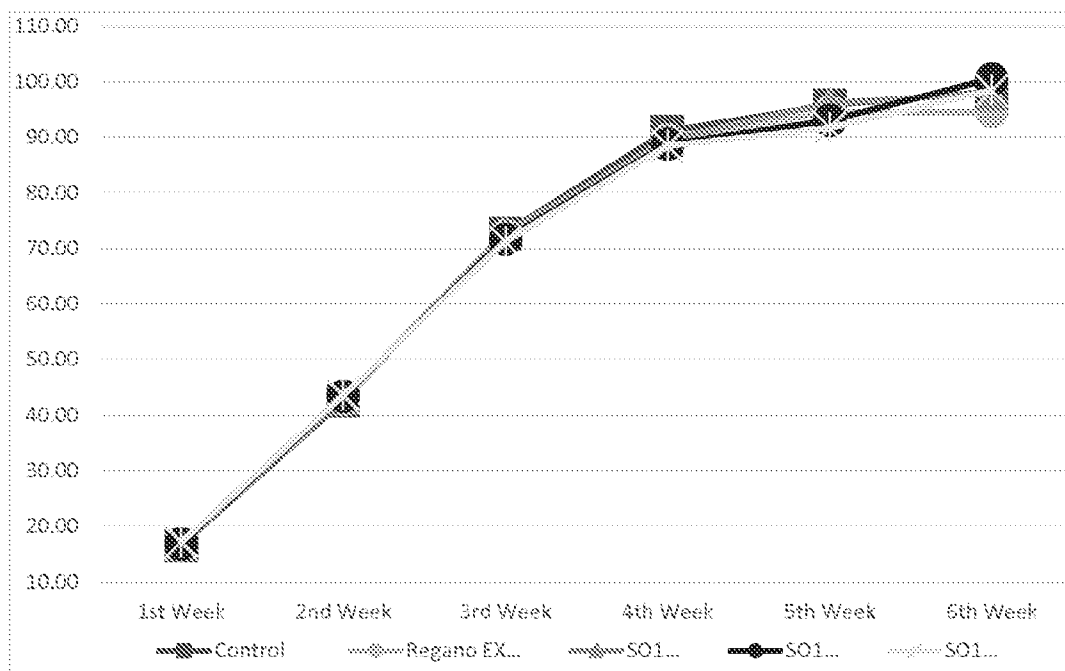


FIG 3A

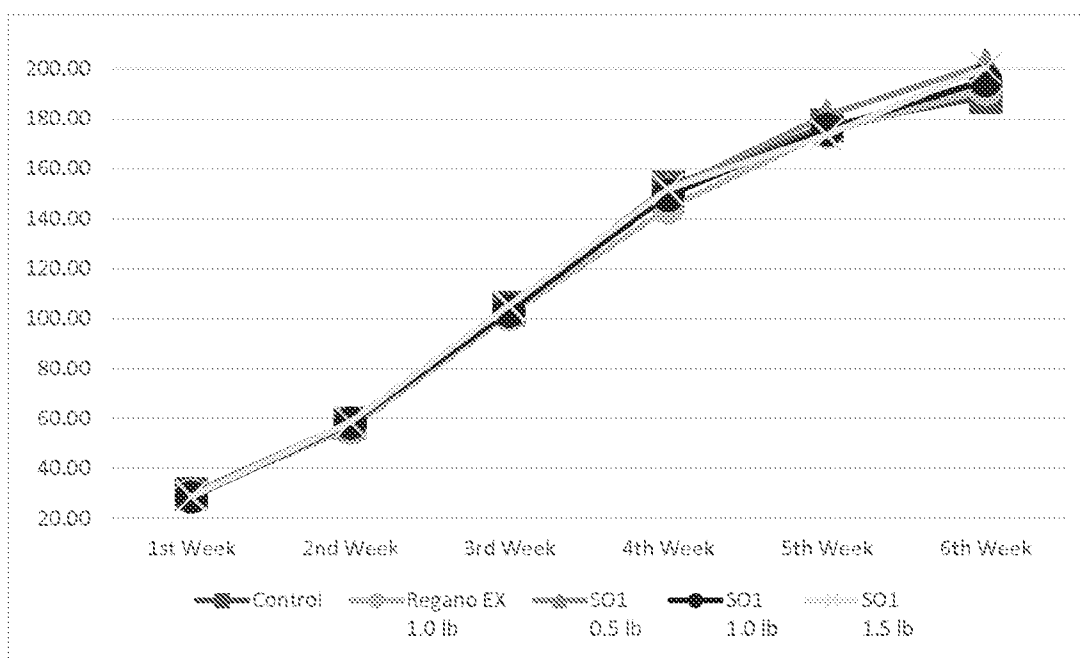


FIG 3B

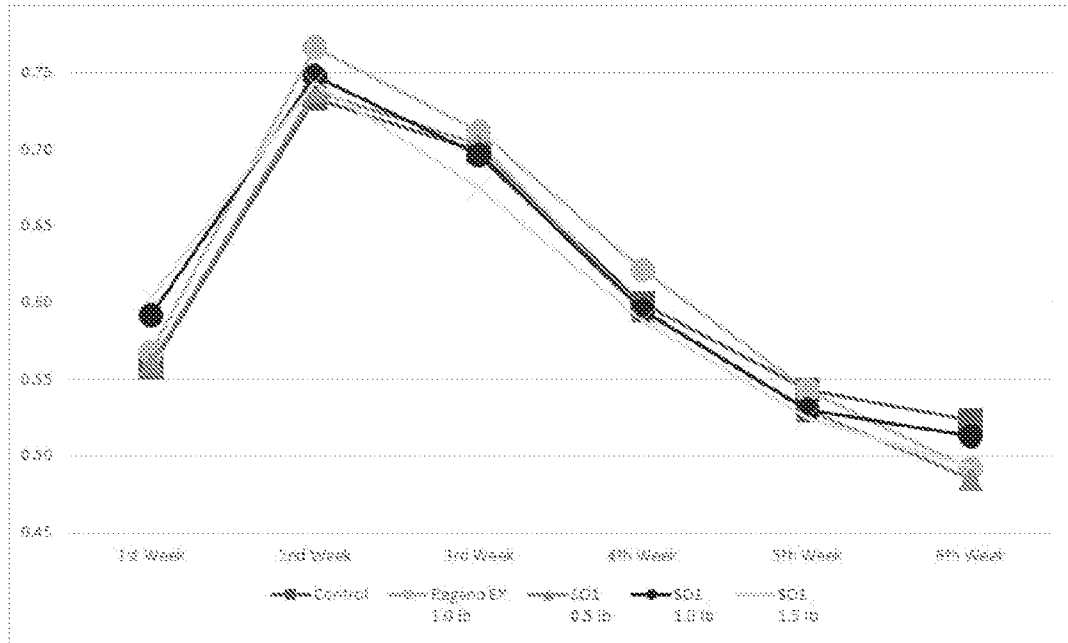


FIG 3C

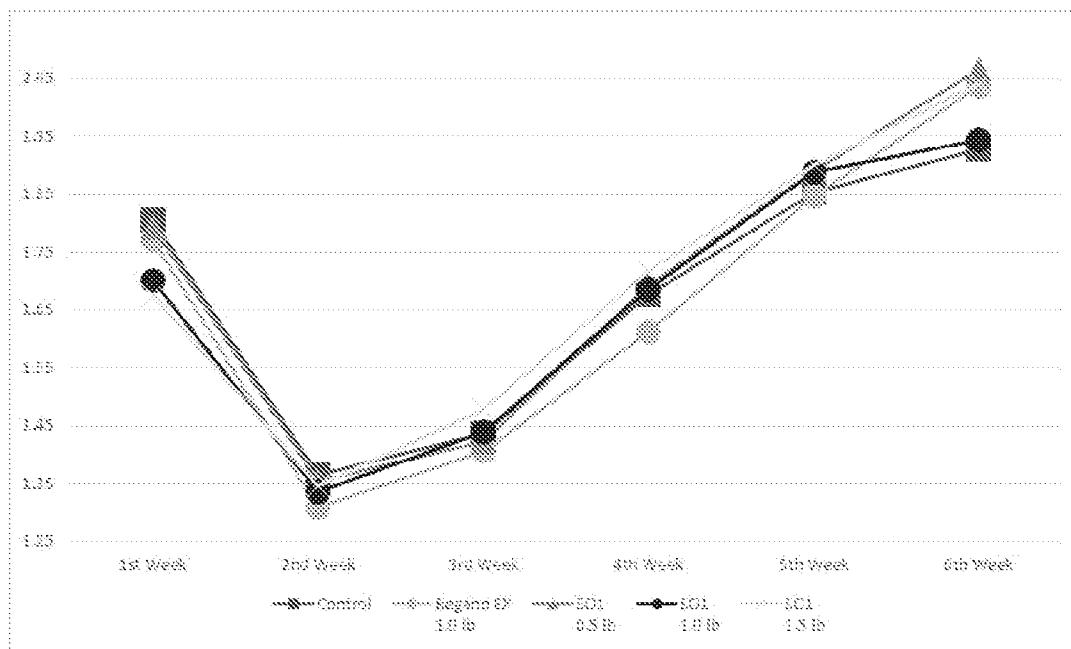


FIG 3D

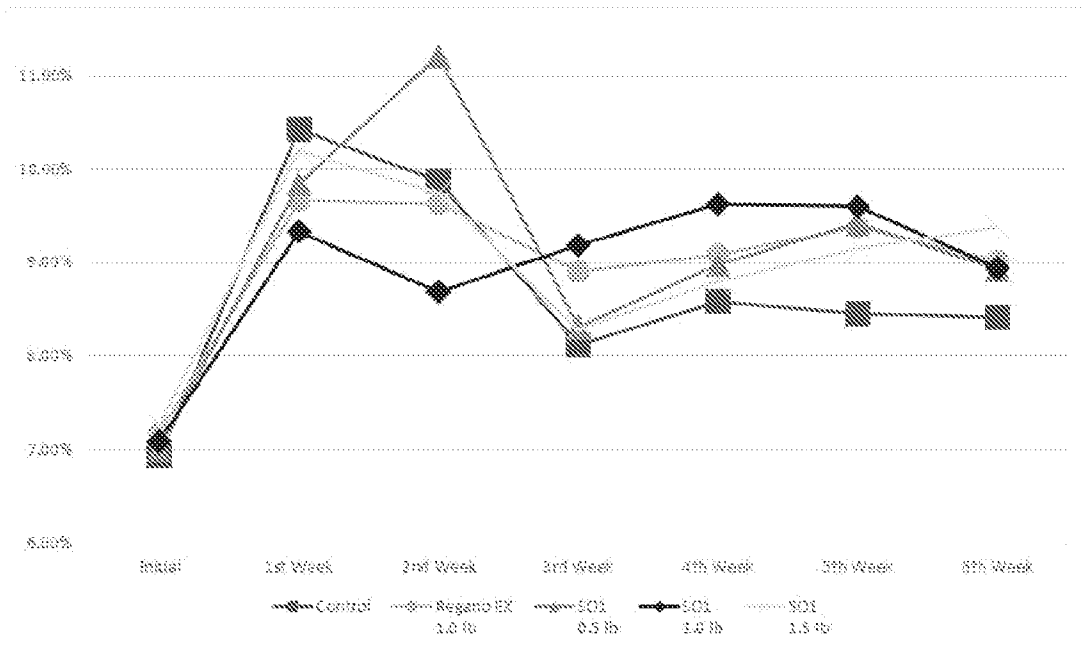


FIG 3E

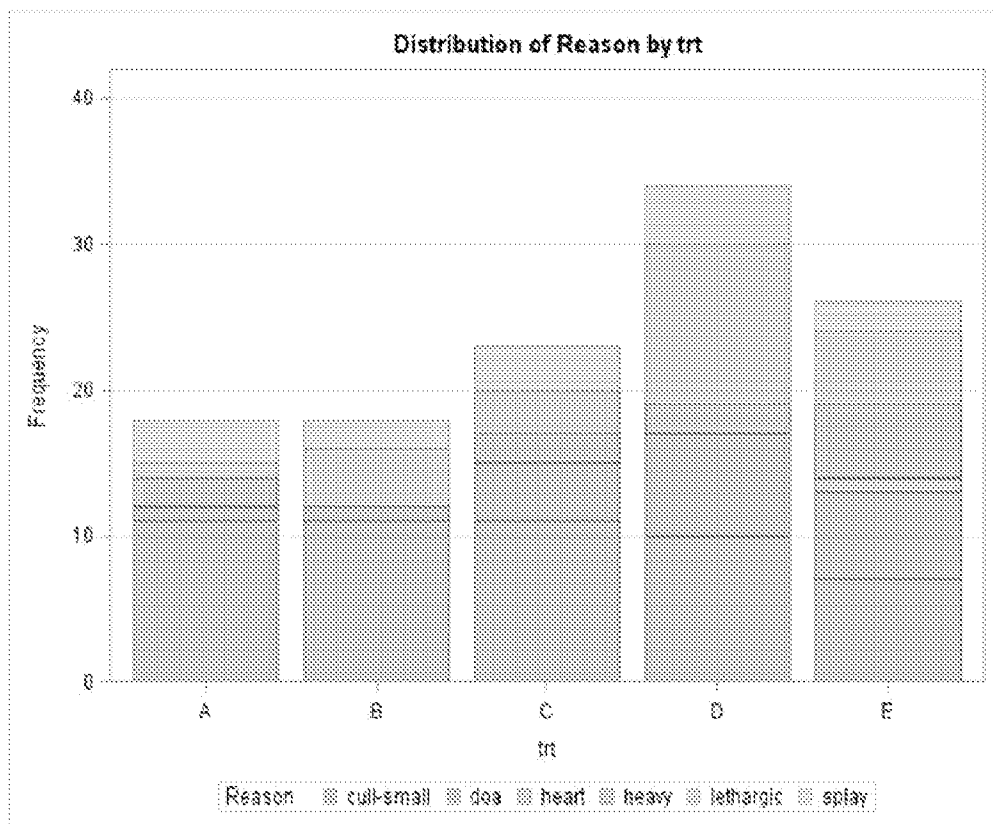


FIG 3F

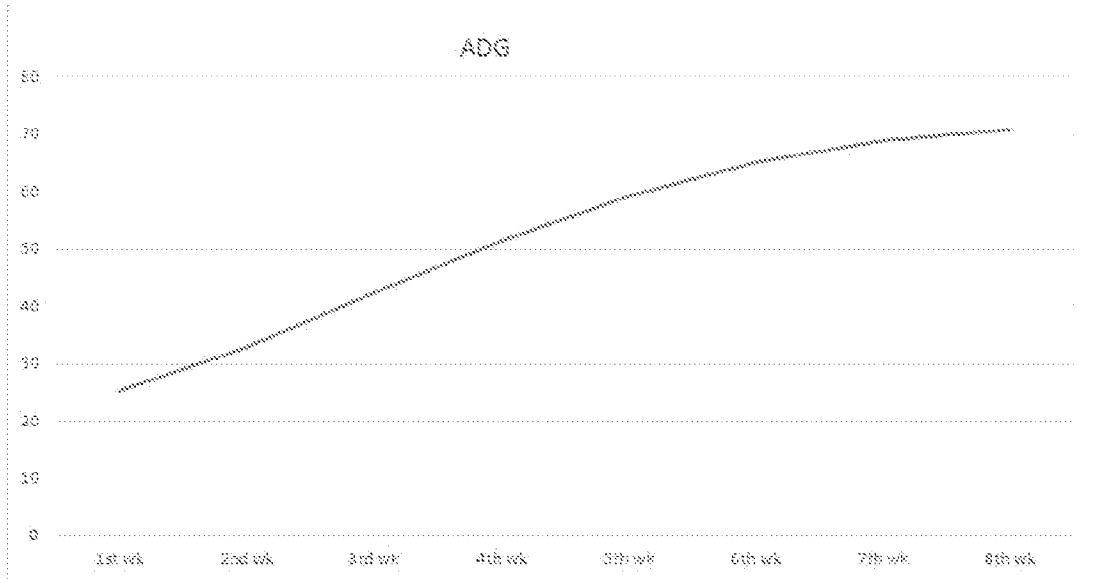


FIG 4A

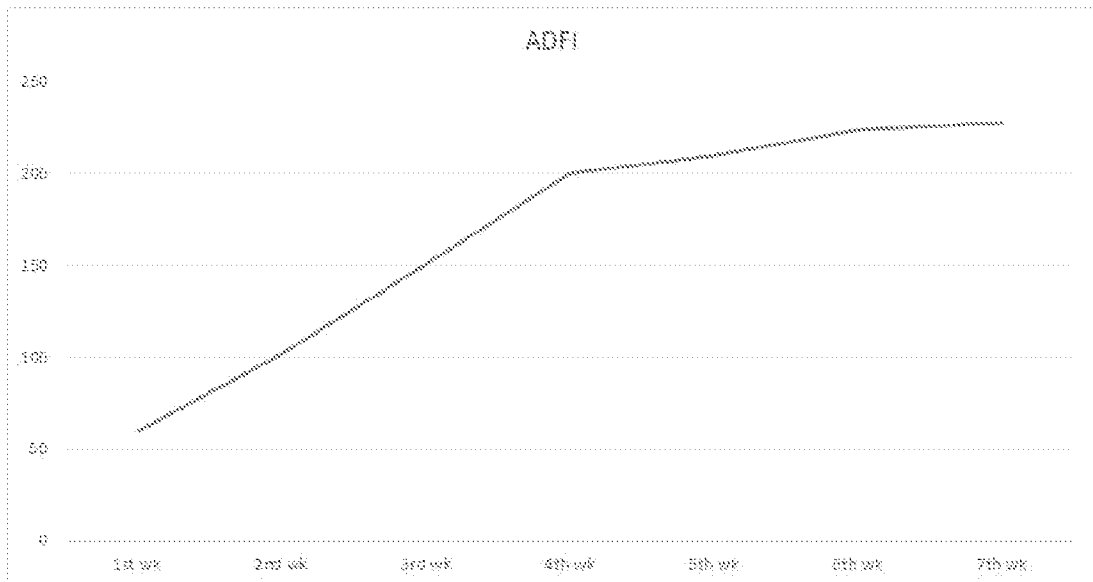


FIG 4B

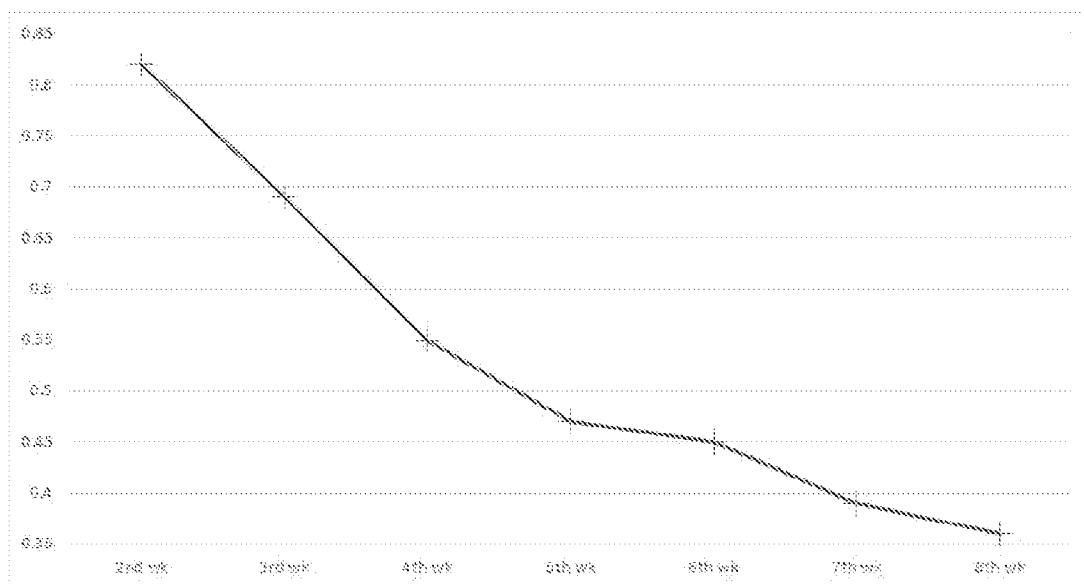


FIG 4C

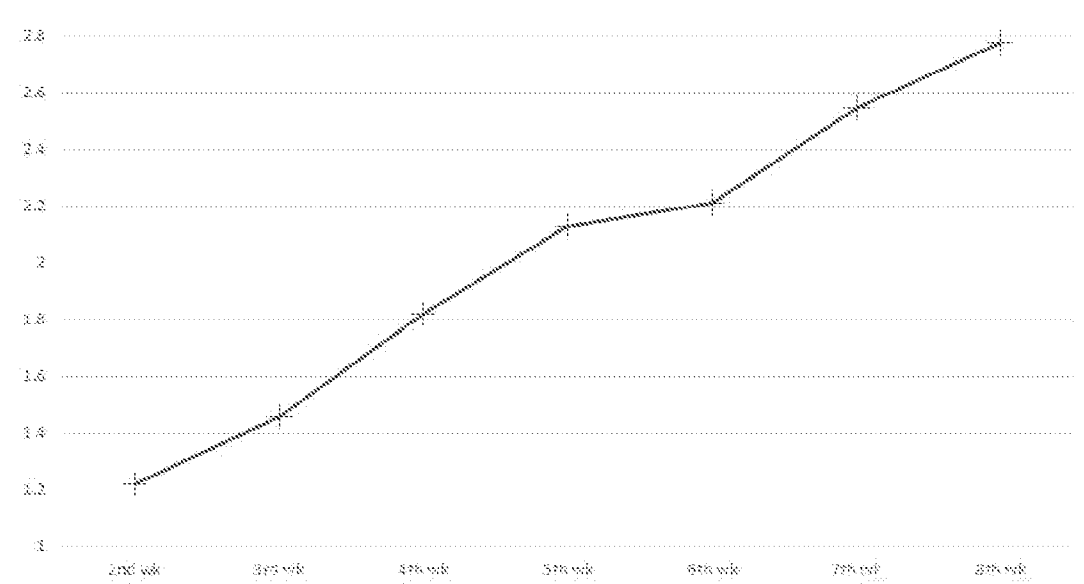


FIG 4D

Electronic Acknowledgement Receipt

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First Named Inventor/Applicant Name:	Richard Dale LAMB
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2		App_As_Filed.pdf	160738	yes	27
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3	Authorization for Extension of Time all replies	Auth_Ext_Time_CC.pdf	16484	no	1
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