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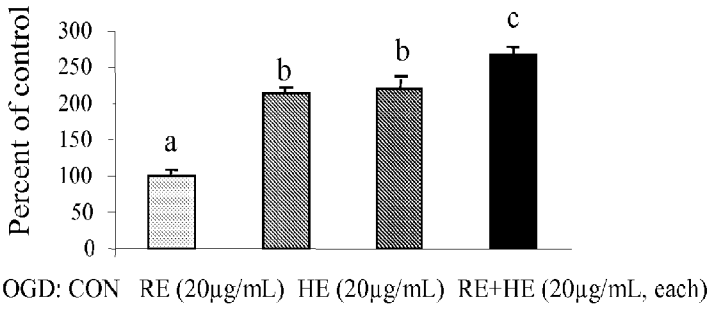

FIG. 4B

(57) Abstract: Provided are compositions and processes of treating or preventing one or more conditions related to a protein involved in circadian rhythm. A composition includes an extract of rosemary, an extract of *hemerocallis fulva*, active portion or component thereof, or combinations thereof, optionally provided as a component of a dietary supplement. The presence of one or more active ingredients in the extracts optionally administered at a targeted administration time alters the expression of one or more genes or proteins involved in circadian rhythm, illustratively CLOCK, BMAL1, FBXL3, FBXL21, or SIRT1.

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COMPOSITIONS AND METHODS FOR THE TREATMENT OR PROPHYLAXIS OF CIRCADIAN PROTEIN RELATED CONDITIONS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application depends from and claims priority to U.S. Provisional Application No: 61/903,434 filed November 13, 2013, and U.S. Provisional Application No: 61/903,440 filed November 13, 2013, the entire contents of each of which are incorporated herein by reference

FIELD OF THE INVENTION

[0002] The present invention relates to dietary supplement compositions containing rosemary or *Hemerocallis fulva* extracts and methods for treatment of prophylaxis of conditions related to a circadian rhythm.

BACKGROUND OF THE INVENTION

[0003] Living organisms from cyanobacteria to mammals display circadian rhythms (i.e., oscillations with 24-h periodicities) in multiple physiological and behavioral processes. These rhythms are found in nearly all living organisms. Circadian rhythms are generated endogenously and function under tightly regulated genetic control.

[0004] Circadian rhythms control a variety of biological processes, including sleep/wake cycles, body temperature, hormone secretion, gastrointestinal function, metabolic glucose homeostasis, and immunological functions. Biological clocks exhibiting circadian rhythms exist in virtually all tissues, with a series of clock genes generating the rhythm through protein feedback effects on their own synthesis.

[0005] These multiple endogenous clocks are distributed in every cell of the organism, which may result in each organ having its own timed circadian rhythm. A complex mechanism of activation and feedback regulate the expression, post-translational modification, translocation, and degradation of circadian proteins. The transcription factor complex CLOCK–BMAL1 is a core component of the molecular clock machinery that drives circadian gene expression and physiology in mammals. CLOCK and BMAL1 are each basic helix-loop-helix (bHLH) PAS-domain transcription factors that together form the positive elements of the central oscillatory loop. CLOCK and BMAL1 form a heterodimer that binds to E-box elements in the promoters of target genes. Some of the primary genes under transcriptional control by CLOCK:BMAL1

encode the three *Period* (*mPer1, mPer2,* and *mPer3*) proteins and two *Cryptochrome*genes (*mCry1* and *mCry2*) proteins. Following translation of the Per and Cry proteins, they translocate to the nucleus where they act as potent inhibitors of CLOCK:BMAL1-induced gene transcription forming a negative feedback loop and regulating the rhythmic expression of many genes. The PERIOD protein mPER2, the gene of which is also under CLOCK:BMAL1 transcriptional control, functions as a stimulator of Bmal1 transcription, forming the positive feedback loop and enhancing CLOCK:BMAL1 activity. The regulation of these positive and negative feedback loops regulates the circadian rhythm within the cell.

[0006] SIRT1, a nicotinamide adenine dinucleotide-dependent sirtuin, has been shown to promote cell survival by inhibiting apoptosis or cellular senescence in mammalian cells. Recent studies have provided a link between the cellular metabolic function of SIRT1 and the circadian rhythm (controlled by the CLOCK:BMAL1 machinery) where it has been shown that SIRT1 controls circadian clock circuitry and promotes cell survival providing a connection with age-related neoplasms. Also, circadian function decays with aging in normal mice, and boosting their SIRT1 levels in the brain could prevent this decay. Conversely, loss of SIRT1 function impairs circadian control in young mice, mimicking what happens in normal aging. Moreover, SIRT1 has been shown to exert this control by regulating the genes BMAL1 and CLOCK, the two major keepers of the central circadian clock.

[0007] Oxygen and circadian rhythmicity are essential in a myriad of physiological processes to maintain homeostasis, from blood pressure and sleep/wake cycles, as well as in cellular signaling pathways that play critical roles in health and disease. Oxidative stress can induce the dysregulated circadian rhythms. Thus, there is a need for new compositions and methods for regulating proper protein expression and circadian rhythm.

SUMMARY OF THE INVENTION

[0008] The following summary of the invention is provided to facilitate an understanding of some of the innovative features unique to the present invention and is not intended to be a full description. A full appreciation of the various aspects of the invention can be gained by taking the entire specification, claims, drawings, and abstract as a whole.

[0009] Maintenance of normal hemostasis is vital to a healthy physiology. Stresses in a subject can result in physiological changes that destroy this hemostasis. The present inventions

provide methods of ameliorating or preventing the effects of stress in a subject by the administration of particular compositions that reverse physiological responses to stress.

[0010] Provided are processes and compositions for the treatment or prevention of a disease or condition related to the expression of a circadian rhythm related protein including: an effective amount of an extract of rosemary, an extract of *hemerocallis fulva*, active portion or component thereof, or combinations thereof, said extract formulated for administering to a subject in need of treatment of a disease or condition related to a circadian rhythm; and ameliorating, preventing, or modulating a symptom of said disease or condition in said subject whereby said effective amount is sufficient to alter one or more expression characteristics of a protein selected from the group consisting of CLOCK, BMAL1, FBXL3, FBXL21, SIRT1, or combinations thereof, in said subject.

[0011] In the processes or compositions, an extract is optionally water extract. Optionally an extract or active portion or component thereof is optionally a portion of or used solely as a dietary supplement. In some aspects, an extract includes ursolic acid at 10% by weight or greater, optionally 25% by weight or greater. An extract is optionally solely ursolic acid. In some aspects, ursolic acid is an active component or portion of an extract. Optionally a composition includes or consists of ursolic acid.

[0012] A composition is optionally administered at or between -4 hours to 12 hours after light exposure. In some aspects, the administration time occurs at or between 0 hours to 12 hours after light exposure, optionally at or between 1 hours to 3 hours after light exposure or 10-14 hours after light exposure, optionally at or between -4 hours to 0 hours prior to light exposure. Administration is optionally once daily, twice daily, more frequently, or on an as needed basis. Administration is optionally for a period of 2 weeks or more, optionally 4 weeks or more, optionally three months or more.

[0013] A disease or condition that is treated or prevented is optionally jet lag. Treating or ameliorating jet lag is optionally achieved by administration prior to or following travel involving a change in time zone.

[0014] In some aspects, a disease or condition is a hangover. An extract, active portion or component thereof, is optionally administered prior to, during, or following the consumption of alcohol, or combinations thereof.

[0015] In some aspects, a disease or condition is metabolic condition related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, or SIRT1. A

metabolic condition is optionally abnormal cholesterol level, obesity, metabolic syndrome or element thereof, hyperglycemia, hypoglycemia, abnormal insulin production, or diabetes.

[0016] In some aspects, a disease or condition is an inflammatory disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

[0017] In some aspects, a disease or condition is a neurological disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. A neurological disorder is optionally Alzheimer's disease.

[0018] In some aspects, a disease or condition is a muscular disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. A muscular disorder is optionally muscular dystrophy or myopathy.

[0019] In some aspects, a disease or condition is a sleep disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. A sleep disorder is optionally insomnia, jet lag, shift work sleep disorder, delayed sleep phase syndrome (DSPS), advanced sleep phase syndrome (ASPS), non 24-hour sleep wake disorder or irregular sleep-wake pattern. For a sleep disorder administration is optionally at or between -4 hours to 12 hours after light exposure. In some aspects, the administration time occurs at or between 0 hours to 12 hours after light exposure, optionally at or between 1 hours to 3 hours after light exposure or 10-14 hours after light exposure, optionally at or between -4 hours to 0 hours prior to light exposure. Administration is optionally once daily, twice daily, more frequently, or on an as needed basis.

[0020] In some aspects, a disease or condition is a psychiatric disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. A psychiatric disorder is optionally depression, seasonal affective disorder, dementia, or rapid-cycling bipolar disorder.

[0021] In some aspects, a disease or condition is a cardiovascular disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. Optionally, a cardiovascular disorder is abnormal blood pressure or abnormal heart rate. In some aspects, a cardiovascular disorder is atherosclerosis or cardiomyopathy.

[0022] In some aspects, a disease or condition is a liver toxicity related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

[0023] In some aspects, a disease or condition is a disorder of the brain related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. Optionally, a disorder of the brain is stroke or brain degeneration due to free radicals.

[0024] In some aspects, a disease or condition is obesity.

[0025] In some aspects, a disease or condition is a cellular proliferative disorder, optionally cancer.

[0026] A composition optionally includes 10% or greater ursolic acid, optionally 25% or greater ursolic acid. A composition optionally consists of ursolic acid. A composition optionally consists essentially of ursolic acid and excludes other compositions that are useful for the treatment or prevention of a disease. A composition is optionally provided as a dietary supplement or component thereof. A dietary supplement is optionally in the form of a powder, gel, liquid, food, solid, or other form.

[0027] The compositions are similarly suitable for use in processes essentially as described for the prevention or treatment of a disease or condition related to the expression of a circadian rhythm related protein. A process includes administering to a subject in need of treatment or amelioration of a disease or condition related to expression of a protein selected from the group consisting of CLOCK, BMAL1, FBXL3, FBXL21, SIRT1, or combinations thereof, composition including an effective amount of an extract of rosemary, an extract of *hemerocallis fulva*, active portion or component thereof, or combinations thereof. An composition optionally includes ursolic acid at 10% by weight or greater, optionally 25% or greater, optionally solely including ursolic acid, or ursolic acid as the sole active directed to treatment or prevention of the disease or condition. A composition is optionally provided as a dietary supplement or component thereof. A dietary supplement is optionally in the form of a powder, gel, liquid, food, solid, or other form.

[0028] Process are provided for treatment or prevention of one or more of a variety of conditions. A disease or condition that is treated or prevented is optionally jet lag. Treating or ameliorating jet lag is optionally achieved by administration prior to or following travel involving a change in time zone.

[0029] In some aspects, a disease or condition is a hangover. An extract, active portion or component thereof, is optionally administered prior to, during, or following the consumption of alcohol, or combinations thereof.

[0030] In some aspects, a disease or condition is metabolic condition related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, or SIRT1. A

metabolic condition is optionally abnormal cholesterol level, obesity, metabolic syndrome or element thereof, hyperglycemia, hypoglycemia, abnormal insulin production, or diabetes.

[0031] In some aspects, a disease or condition is an inflammatory disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

[0032] In some aspects, a disease or condition is a neurological disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. A neurological disorder is optionally Alzheimer's disease.

[0033] In some aspects, a disease or condition is a muscular disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. A muscular disorder is optionally muscular dystrophy or myopathy.

[0034] In some aspects, a disease or condition is a sleep disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. A sleep disorder is optionally insomnia, jet lag, shift work sleep disorder, delayed sleep phase syndrome (DSPS), advanced sleep phase syndrome (ASPS), non 24-hour sleep wake disorder or irregular sleep-wake pattern. For a sleep disorder administration is optionally at or between -4 hours to 12 hours after light exposure. In some aspects, the administration time occurs at or between 0 hours to 12 hours after light exposure, optionally at or between 1 hours to 3 hours after light exposure or 10-14 hours after light exposure, optionally at or between -4 hours to 0 hours prior to light exposure. Administration is optionally once daily, twice daily, more frequently, or on an as needed basis.

[0035] In some aspects, a disease or condition is a psychiatric disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. A psychiatric disorder is optionally depression, seasonal affective disorder, dementia, or rapid-cycling bipolar disorder.

[0036] In some aspects, a disease or condition is a cardiovascular disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. Optionally, a cardiovascular disorder is abnormal blood pressure or abnormal heart rate. In some aspects, a cardiovascular disorder is atherosclerosis or cardiomyopathy.

[0037] In some aspects, a disease or condition is a liver toxicity related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

[0038] In some aspects, a disease or condition is a disorder of the brain related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1. Optionally, a disorder of the brain is stroke or brain degeneration due to free radicals.

[0039] In some aspects, a disease or condition is obesity.

[0040] In some aspects, a disease or condition is a cellular proliferative disorder, optionally cancer.

[0041] A composition is optionally administered at or between -4 hours to 12 hours after light exposure. In some aspects, the administration time occurs at or between 0 hours to 12 hours after light exposure, optionally at or between 1 hours to 3 hours after light exposure or 10-14 hours after light exposure, optionally at or between -4 hours to 0 hours prior to light exposure. Administration is optionally once daily, twice daily, more frequently, or on an as needed basis. Administration is optionally for a period of 2 weeks or more, optionally 4 weeks or more, optionally three months or more.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042] FIG. 1A illustrates the effects of RME and HFE on CLOCK protein expression in C6 cells;

[0043] FIG. 1B illustrates the effects of RME and HFE on CLOCK protein expression in C6 cells;

[0044] FIG. 2A illustrates RME increased BMAL1 protein levels in 4hr oxygen-glucose deprivation (OGD) and 2hr reperfusion treated C6 cells;

[0045] FIG. 2B illustrates RME increased FBXL21 protein levels in 4hr oxygen-glucose deprivation (OGD) and 2hr reperfusion treated C6 cells;

[0046] FIG. 3A illustrates SIRT1 levels increased in OGD Rat L-6 cells treated with RME, HFE, or both;

[0047] FIG. 3B illustrates quantifiable increases in SIRT1 levels in OGD treated Rat L-6 cells;

[0048] FIG. 4A illustrates CLOCK protein levels increased in OGD Rat L-6 cells treated with RME, HFE, or both;

[0049] FIG. 4B illustrates quantifiable increases in CLOCK levels in OGD treated Rat L-6 cells by RME, HFE, or both;

[0050] FIG. 5A illustrates Bmal1 protein levels increased in OGD Rat L-6 cells treated with RME, HFE, or both;

[0051] FIG. 5B illustrates quantifiable increases in Bmal1 levels in OGD treated Rat L-6 cells by RME, HFE, or both;

DETAILED DESCRIPTION OF ASPECTS OF THE INVENTION

[0052] The following description of particular aspect(s) is merely exemplary in nature and is in no way intended to limit the scope of the invention, its application, or uses, which may, of course, vary. The invention is described with relation to the non-limiting definitions and terminology included herein. These definitions and terminology are not designed to function as a limitation on the scope or practice of the invention but are presented for illustrative and descriptive purposes only. While the processes or compositions are described as an order of individual steps or using specific materials, it is appreciated that steps or materials may be interchangeable such that the description of the invention may include multiple parts or steps arranged in many ways as is readily appreciated by one of skill in the art.

[0053] Provided are processes for treating, preventing, or modulating a disease or condition related to circadian rhythm machinery component in a subject. Altering a circadian rhythm machinery component is understood as altering, optionally increasing, the expression level, post-translational modification state, nuclear or cytoplasmic location or translocation, or RNA expression rate of a protein normally involved in a 24-hour or other regular cycle in one or more cell types in a subject. A circadian machinery component is optionally RNA or protein, or modifications thereof that are or encode CLOCK, BMAL1, SIRT1, FBXL3, FBXL21, or combinations thereof.

[0054] A disease or condition (e.g. disorder) is one that is due to an irregularity, undesirable expression characteristic, or other element that is caused directly or indirectly by one or more of CLOCK, BMAL1, SIRT1, FBXL3, or FBXL21, or RNA encoding one or more of such proteins. A process includes administering to a subject having a disease or condition associated with an undesirable circadian rhythm function and in need of such treatment an effective amount of an extract of rosemary, an extract of *hemerocallis fulva*, active portion thereof, or combinations thereof or a dietary supplement containing in whole or in part of an extract of rosemary, an extract of *hemerocallis fulva*, active portion thereof, or combinations thereof. Such an administration is at an administration time. The administration of the extract of rosemary, an

extract of *hemerocallis fulva*, active portion thereof, or combinations thereof or a dietary supplement containing such will alter an expression characteristic of a protein of CLOCK, BMAL1, FBXL3, FBXl21, SIRT1, or combinations thereof in the subject. As such, the invention has utility for treating, preventing, or otherwise modulating a condition caused directly or indirectly by altering or adjusting one or more expression characteristics of a protein involved in a circadian rhythm in a cell.

[0055] It is appreciated herein that the singular forms "a," "an," and "the" include plural reference unless the context clearly dictates otherwise. The term "including" is used to mean "including but not limited to."

[0056] An "expression characteristic" is the transcription of a gene encoding a circadian rhythm protein, translation of RNA encoding a circadian rhythm protein, localization of RNA encoding a circadian rhythm protein, protein function, protein localization, protein post-translational modification, or other parameter recognized in the art related to protein expression and function.

[0057] In some aspects, the disease or condition is a sleep disorder, optionally insomnia, jet lag, shift work sleep disorder, delayed sleep phase syndrome (DSPS), advanced sleep phase syndrome (ASPS), a non-24-hour sleep wake disorder or irregular sleep-wake pattern. In some aspects, disease or condition is a psychiatric disorder associated with circadian rhythm, optionally depression. In some aspects, the disease or disorder is a neurological disease with a circadian rhythm component, optionally Alzheimer's disease or anorexia nervosa. In some aspects, the disease or disorder is abnormal blood pressure. In some aspects, the disease or disorder is abnormal heart rate. In some aspects, the disease or disorder is asthma. In some aspects, the disease or disorder the treatment of which benefits from increasing or decreasing metabolite levels, such as levels of NAD, NAM or NMN. In some aspects, a disease or condition is excess fat tissue, elevated body mass index, or other weight disorder. In some aspects, a disease or condition is or is an increased risk of a brain injury such as by ischemic stroke. In some aspects a disease or condition is related to free radical induced degeneration of brain tissue. In some aspect, a disease or condition is less than desirable muscle mass. In some aspects, a disease or condition is the need for muscle recovery following exercise. In some aspects, a disease or condition is cortisol suppression. In some aspects, a disease or condition is undesirable testosterone levels. In some aspects, a disease or condition is a hangover or other condition related to abnormal hydration or salt levels. In some aspects, a disease or condition is

excess inflammation at one or more sites or systemic inflammation. In some aspects, a disease or condition is atherosclerosis. In some aspects, a disease or condition is hyperglycemia or hypoglycemia. In some aspects, a disease or condition is the presence of a toxin in a subject or liver disorder resulting or related to the presence of a toxin. In some aspects, the disease or disorder is anorexia nervosa. In some aspects, the disease or condition is abnormal blood pressure. In some aspects, the disease or condition is abnormal heart rate. In some aspects, the disease or condition is asthma. In some aspects, the disease or condition is a metabolic disorder. In some aspects, the metabolic disorder is diabetes, abnormal insulin secretion, abnormal plasma glucose levels, obesity, or metabolic syndrome (or element thereof). In some aspects, the disease or condition is cancer. In some aspects, treating comprises ameliorating symptoms of the disease or condition.

[0058] In some aspects, a disease or condition is a metabolic disorder. Specific metabolic disorders, diseases or conditions optionally include insulin resistance, diabetes, diabetes related conditions or disorders, or metabolic syndrome.

[0059] In some aspects, a disease or condition is a cardiovascular disease. Cardiovascular diseases that can be treated or prevented include cardiomyopathy or myocarditis, illustratively idiopathic cardiomyopathy, metabolic cardiomyopathy, alcoholic cardiomyopathy, drug-induced cardiomyopathy, ischemic cardiomyopathy, and hypertensive cardiomyopathy. In some aspects, a cardiovascular disease is atheromatous disorders of the major blood vessels (macrovascular disease) such as the aorta or other coronary arteries, the carotid arteries, the cerebrovascular arteries, the renal arteries, the iliac arteries, the femoral arteries, or the popliteal arteries. Other vascular diseases that can be treated or prevented include those related to the retinal arterioles, the glomerular arterioles, the vasa nervorum, cardiac arterioles, and associated capillary beds of the eye, the kidney, the heart, and the central and peripheral nervous systems.

[0060] In some aspects a disease or condition is a neurological disease. Neurological diseases illustratively include neurodegenerative diseases optionally including stroke, Alzheimer's disease (AD), Parkinson's disease (PD), Huntington's disease (HD), amyotrophic lateral sclerosis (ALS; Lou Gehrig's disease), diffuse Lewy body disease, chorea-acanthocytosis, primary lateral sclerosis, Multiple Sclerosis (MS), Friedreich's ataxia, Periventricular leukomalacia (PVL), ALS-Parkinson's-Dementia complex of Guam, Wilson's disease, cerebral palsy, progressive supranuclear palsy (Steel-Richardson syndrome), bulbar and pseudobulbar palsy, diabetic retinopathy, multi-infarct dementia, macular degeneration, Pick's disease, diffuse

Lewy body disease, prion diseases such as Creutzfeldt- Jakob, Gerstmann-Straussler-Scheinker disease, Kuru and fatal familial insomnia, primary lateral sclerosis, degenerative ataxias, Machado-Joseph disease/spinocerebellar ataxia type 3 and olivopontocerebellar degenerations, spinal and spinobulbar muscular atrophy (Kennedy's disease), familial spastic paraplegia, Wohlfart-Kugelberg-Welander disease, Tay-Sach's disease, multisystem degeneration (Shy-Drager syndrome), Gilles De La Tourette's disease, familial dysautonomia (Riley-Day syndrome), Kugelberg-Welander disease, subacute sclerosing panencephalitis, Werdnig-Hoffmann disease, synucleinopathies (including multiple system atrophy), Sandhoff disease, cortical basal degeneration, spastic paraparesis, primary progressive aphasia, progressive multifocal leukoencephalopathy, striatonigral degeneration, familial spastic disease, chronic epileptic conditions associated with neurodegeneration, Binswanger's disease, and dementia (including all underlying etiologies of dementia).

[0061] In some aspects, a disease or condition is a muscular disease. Muscular diseases illustratively include neuromuscular diseases such as muscular dystrophy and myopathy.

[0062] In some aspects, a disease or condition is a mitochondrial disease. Mitochondrial diseases optionally include KSS (chronic progressive external ophthalmoplegia), MERRF (myoclonus epilepsy associated with ragged-red fibers; Fukuhara syndrome), MELAS, Leber's disease, Leigh encephalopathia and Pearson's disease.

[0063] In some aspects, a disease or condition is an insulin related condition. Insulin resistance disorders include any disease or condition that is caused by or contributed to by insulin resistance. Illustrative non-limiting examples include diabetes, obesity, metabolic syndrome, insulin-resistance syndromes, syndrome X, insulin resistance, high blood pressure, hypertension, high blood cholesterol, dyslipidemia, hyperlipidemia, dyslipidemia, atherosclerotic disease including stroke, coronary artery disease or myocardial infarction, hyperglycemia, hyperinsulinemia and/or hyperproinsulinemia, impaired glucose tolerance, delayed insulin release, diabetic complications, including coronary heart disease, angina pectoris, congestive heart failure, stroke, cognitive functions in dementia, retinopathy, peripheral neuropathy, nephropathy, glomerulonephritis, glomerulosclerosis, nephrotic syndrome, hypertensive nephrosclerosis some types of cancer (such as endometrial, breast, prostate, and colon), complications of pregnancy, poor female reproductive health (such as menstrual irregularities, infertility, irregular ovulation, polycystic ovarian syndrome (PCOS)), lipodystrophy, cholesterol related disorders, such as gallstones, cholescystitis and cholelithiasis, gout, obstructive sleep

apnea and respiratory problems, osteoarthritis, and prevention and treatment of bone loss, e.g. osteoporosis.

[0064] Provided are materials in the form of botanical extracts, such as an extract of rosemary, an extract of *hemerocallis fulva*, active portion thereof, or combinations thereof, alone or as part of a dietary supplement that have utility for altering one or more expression characteristics of a protein involved in a circadian rhythm in a subject. The extract, active portion thereof, or dietary supplement may be in pharmaceutical dietary supplement composition in solid, semi-solid, or liquid dosage forms, such as, for example, tablets, chewables, suppositories, pills, capsules, powders, liquids, or suspensions, and may be provided in unit dosages suitable for a single administration. Time release preparations are also contemplated as effective dosage formulations. The compositions may include an effective amount of a selected extract of rosemary, *hemerocallis fulva*, active portion thereof, or combinations, optionally in combination with a pharmaceutically acceptable carrier and, in addition, may include other medicinal agents, pharmaceutical agents, carriers, or diluents.

[0065] The extracts are recognized to include an active ingredient as an active portion of an extract, or the sole portion of an extract. "Active ingredient" refers a component present in the extract that renders, directly or indirectly, the intended effect of the extract. In some aspects, an active ingredient is ursolic acid. Extraction parameters such as water quality, heating temperature, drying temperature, heating time, drying time, and filtering processes all contribute to the quality and efficiency of the process. Water quality directly affects the concentration of active ingredient(s). Poor quality water may cause active ingredient(s) to become decomposed or oxidized during or following the extraction process.

[0066] The rosemary or *hemerocallis fulva* may be obtained from various resources. Rosemary, or *Rosmarinus officinalis*, is a woody bush native to the Mediterranean region. Extracts of rosemary may be made from *Rosmarinus* spp. and preferably from the leaves and young flowering tops of fresh rosemary (*Rosmarinus officinalis L.* and its cultivars). Rosemary extraction may be performed by harvesting the leaves of a rosemary plant and reducing them in size such as by chopping to improve solvent penetration. A typical particle size is optionally 0.5 - 5.0 mm, or any value or range therebetween. In some aspects, the leaf is chopped into a powder type substance with a particle size of less than 0.5 mm. The chopped plant material is combined with a suitable extraction solvent such as water and/or a low molecular weight alcohol (e.g. C_4-C_6 alcohol) such as ethanol. The plant material is combined with the solvent for an extraction

time of 18 to 36 hours. The extraction temperature is optionally the range 10°C to 45°C. The resulting extract liquid is separated from the solid material and filtered, optionally with a sterile filter. Optionally, the resulting extract is poured onto nonstick tray and allowed to dry at 80-90°C. Vacuum-spray dry equipment is optionally used for the drying procedure. The resulting dry extract powder is weighed. An extraction ratio is calculated as w/20 x100% with w as the weight (g) of the dry extract powder. The sample and water ratio, heat time, volume of water in the second extraction may vary depending on the amount of the raw material used for extraction.

[0067] Extracts of *Hemerocallis fulva* are optionally obtained from extraction in an extraction solvent such as water and/or low molecular weight alcohol such as ethanol. Extracts are prepared from plants belonging to the genus *Hemerocallis* of the family Liliaceae of the order Liliales are used. Examples of such plants include Akinowasuregusa (*Homerocallis fulva* L. *sempervirens* M. Hotta or *Homerocallis sempervirens* Araki), Honkanzo (*Hemerocallis fulva* L. var. *fulva*), Nokanzo (*Hemerocallis fulva* L. var. *longituba* Maxim or *Hemerocallis longituba* Miq.), and Yabukanzo (*Hemerocallis fulva* L. var. *kwanso* Regal). An extract is optionally prepared from whole plants or plant parts, such as leaves, stems, and roots.

[0068] In some aspects, an extract is prepared by drying the plant material and optionally cutting the material into a suitable size for extraction, such as the sizes described for rosemary. The plant material is combined with an extraction solvent (e.g. water, aqueous buffer, low molecular weight alcohol, or combinations thereof) that is preheated to a temperature of 60°C to 100°C for an extraction time, typically of 20 to 90 minutes. The particulate material is then removed by gravity separation, centrifugation, or filtering, optionally with a filter size suitable for aseptic filtration. The resulting extract is optionally poured onto nonstick tray and allowed to dry at 80-90°C. Vacuum-spray dry equipment is optionally used for the drying procedure. The resulting dry extract powder is weighed. An extraction ratio is calculated as w/20 x100% with w as the weight (g) of the dry extract powder. The sample and water ratio, heat time, volume of water in the extraction may vary depending on the amount of the raw material used for extraction.

[0069] In some aspects, a second extraction of either plant material is performed optionally using the same extraction parameters or differing extraction parameters. Optionally, a second extraction is performed in a low molecular weight alcohol optionally of C_2-C_4. The first and second extraction solutions are optionally combined together and dried.

[0070] In some aspects, an extract includes or consists of ursolic acid as an active ingredient. Ursolic acid is optionally present in an extract at a concentration of 10 weight percent or greater. In some aspects, ursolic acid is present in an extract at a concentration of 25 weight percent or greater. Optionally, ursolic acid is present at a weight percent at or in excess of 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 96, 97, 98, 99, 99.1, 99.2, 99.3, 99.4, 99.5, 99.6, 99.7, 99.8, or 99.9.

[0071] While ursolic acid is descried as a component of or the product representing an extract, it is appreciated that the term "extract" may in some aspects include otherwise isolated, purified, or chemically synthesized ursolic acid. As such, an "extract" is in some aspects ursolic acid obtained either by extraction from a natural or non-natural source, or used as a chemically synthesized ursolic acid.

[0072] Depending on the intended mode of administration, the extract can be in pharmaceutical compositions in the form of solid, semi-solid or liquid dosage forms, such as, for example, tablets, suppositories, pills, capsules, powders, liquids, or suspensions, and may be provided in unit dosages suitable for a single administration. Time release preparations are specifically contemplated as effective dosage formulations. The compositions will include an effective amount of the selected extract in combination with a pharmaceutically acceptable carrier and, in addition, may include other medicinal agents, pharmaceutical agents, carriers, or diluents.

[0073] In a solid composition aspect, conventional nontoxic solid carriers may include, for example, pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharine, talc, cellulose, glucose, sucrose and magnesium carbonate. Liquid pharmaceutically administrable compositions may, for example, be prepared by dissolving or dispersing an active compound with optimal pharmaceutical adjuvants in an excipient, such as water, saline, aqueous dextrose, glycerol, or ethanol, to form a solution or suspension. For example, the pharmaceutical composition may contain minor amounts of nontoxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents, for example, sodium acetate or triethanolamine oleate. Actual methods of preparing such dosage forms are known, or will be apparent, to those skilled in this art; for example, see Remington's The Science and Practice of Pharmacy (20^{th} Edition).

[0074] In oral administration aspects, fine powders or granules of extract, or a liquid extract may contain diluting, dispersing, or surface active agents. The extract may be presented in water or in syrup, in capsules or sachets in the dry state, or in a non-aqueous solution or suspension.

Suspending agents may also be included in tablets, which may include binders and lubricants in a suspension. Flavoring, preserving, suspending, thickening, or emulsifying agents may be also included to modify the taste and texture of the composition. The tablets and granules provided for oral administration may further be coated for ease of digestion.

[0075] In some aspects, the extract containing dietary supplement composition may be combined with one or more other active agents. An active agent optionally functions synergistically with an extract material. Active agents illustratively include vitamins (such as vitamin A, vitamin B, vitamin C, vitamin D, vitamin E or vitamin K), antioxidants (such as acai, wolfberry, alpha lipoic acid, astazanthin, or fucoxanthin), or other regulators of one or more circadian rhythm protein (illustratively resveratrol or polygonum), or any combination of the above. The extract according to the present invention is available as a food additive thereto. Examples include foods in a liquid, semi-liquid, solid, paste, or jelly form.

[0076] Processes are provided for treating, preventing, or modulating a condition directly or indirectly related to an expression characteristic of a circadian rhythm protein in a subject. As used herein, a subject is defined as an organism (such as a human, non-human primate, equine, bovine, murine, or other mammal), or a cell. Illustrative examples of cells include neuronal cells, muscle cells, or any other cell that endogenously or exogenously expresses a circadian machinery component protein.

[0077] The inventors unexpectedly discovered that administration of an extract of rosemary, an extract of *hemerocallis fulva*, or combinations thereof will alter one or more expression characteristics of a circadian rhythm protein. Circadian rhythm protein expression is altered when a cell, optionally a cell in an organism, is contacted by an extract of rosemary, an extract of *hemerocallis fulva*, or combinations thereof. Illustrative examples of proteins include the proteins CLOCK, BMAL1, FBXL3, FBXl21, SIRT1. In some aspects, a protein is not a sirtuin protein.

[0078] The Circadian Locomotor Output Cycles Kaput (CLOCK) protein is optionally altered in one or more expression characteristics in aspects of the invention. Optionally CLOCK protein expression in the cytoplasm or levels in the nucleus following translocation are increased in the inventive processes. Optionally, an extract is an extract of rosemary that increases expression of a CLOCK protein. Optionally, an extract is an extract of *hemerocallis fulva* that increases expression of a CLOCK protein. Contacting a cell with an extract of rosemary, an extract of *hemerocallis fulva*, or combinations thereof is shown to increase the expression of

CLOCK protein within 2 hours of administration. Illustratively, CLOCK protein expression is enhanced (e.g. increased) by a value of 5% to 300% or more, or any value or range therebetween. Optionally, CLOCK protein expression is enhanced by 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 125%, 150%, 200%, 250%, 300%, or more.

[0079] Brain and muscle Arnt-like protein-1 (BMAL1; also known as MOP3 or Arnt3) is a transcription factor known to regulate circadian rhythm. Optionally BMAL1 protein expression in the cytoplasm or levels in the nucleus following translocation are increased in the inventive processes. Optionally, an extract is an extract of rosemary that increases expression of a BMAL1 protein. Optionally, an extract is an extract of *hemerocallis fulva* that increases expression of a BMAL1 protein. Contacting a cell with an extract of rosemary, an extract of *hemerocallis fulva*, or combinations thereof is shown to increase the expression of BMAL1 protein within 2 hours of administration. Illustratively, BMAL1 protein expression is enhanced (e.g. increased) by a value of 5% to 300% or more, or any value or range therebetween. Optionally, BMAL1 protein expression is enhanced by 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 125%, 150%, 200%, 250%, 300%, or more.

[0080] F-box/LRR-repeat protein 3 (FBXL3) is a member of the F-box protein family that functions in phosphorylation-dependent ubiquitination. Optionally FBXL3 protein expression in the cytoplasm or levels in the nucleus following translocation are increased in the inventive processes. Optionally, an extract is an extract of rosemary that increases expression of a FBXL3 protein. Optionally, an extract is an extract of *hemerocallis fulva* that increases expression of a FBXL3 protein. Contacting a cell with an extract of rosemary, an extract of *hemerocallis fulva*, or combinations thereof is shown to increase the expression of FBXL3 protein within 2 hours of administration. Illustratively, FBXL3 protein expression is enhanced (e.g. increased) by a value of 5% to 300% or more, or any value or range therebetween. Optionally, FBXL3 protein expression is enhanced by 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 125%, 150%, 200%, 250%, 300%, or more.

[0081] F-box/LRR-repeat protein 21 (FBXL21) is a member of the F-box protein family that functions in phosphorylation-dependent ubiquitination. Optionally FBXL21 protein expression in the cytoplasm or levels in the nucleus following translocation are increased in the inventive processes. Optionally, an extract is an extract of rosemary that increases expression of

a FBXL21 protein. Optionally, an extract is an extract of *hemerocallis fulva* that increases expression of a FBXL21 protein. Contacting a cell with an extract of rosemary, an extract of *hemerocallis fulva*, or combinations thereof is shown to increase the expression of FBXL21 protein within 2 hours of administration. Illustratively, FBXL21 protein expression is enhanced (e.g. increased) by a value of 5% to 300% or more, or any value or range therebetween. Optionally, FBXL21 protein expression is enhanced by 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 125%, 150%, 200%, 250%, 300%, or more.

[0082] Sirtuin 1 (silent mating type information regulation 2 homolog 1) (SIRT1) is a protein involved in deacetylation of proteins that contribute to cellular regulation. Optionally SIRT1 protein expression in the cytoplasm or levels in the nucleus following translocation are increased in the inventive processes. Optionally, an extract is an extract of rosemary that increases expression of a SIRT1 protein. Optionally, an extract is an extract of *hemerocallis fulva* that increases expression of a SIRT1 protein. Contacting a cell with an extract of rosemary, an extract of *hemerocallis fulva*, or combinations thereof is shown to increase the expression of SIRT1 protein within 2 hours of administration. Illustratively, SIRT1 protein expression is enhanced (e.g. increased) by a value of 5% to 300% or more, or any value or range therebetween. Optionally, SIRT1 protein expression is enhanced by 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 125%, 150%, 200%, 250%, 300%, or more.

[0083] Detecting and optionally quantifying circadian protein expression is achieved by any of many methods known in the art. Illustratively, circadian protein expression is detected and optionally quantified by enzyme linked immunosorbent assay (ELISA), mass spectrometry, western blot, gel electrophoresis optionally coupled with staining such as by Coomassie brilliant blue or silver stain, or by target specific stains, flow cytometry, immunoprecipitation, or by other method known in the art. In some aspects, an ELISA is used to detect and optionally quantify circadian protein expression. For example, ELISA kits for SIRT1 and SIRT2 are available from Enzo Lifesciences, Plymouth Meeting, PA. Kits for other sirtuins are similarly available from commercial sources. Antibodies directed to CLOCK, BMAL1, and SIRT proteins suitable for use in ELISA, western blot, immunofluorescence or other applications are available from Santa Cruz Biotechnology, Santa Cruz, CA. Anti-FBXL21 and anti-FBXL3 antibodies are available from abcam, Cambridge, MA.

[0084] A process optionally includes administration of an extract or dietary supplement containing extract at an administration time in an amount effective to treat the disease or condition or otherwise modulate or ameliorate a symptom of such a disease of condition. Administration is optionally once daily, twice daily or more. Administration optionally is done 1, 2, 3, 4 or more times each day. Optionally, administration is done on an as needed basis. Optionally irregularly, or weekly. Optionally, administration is done once or twice weekly such as when a subject is transitioning from one schedule to another such as due to travel, shift work, weekend to work schedule or work to weekend schedule, or other necessary time. Optionally, an administration time is following exercise. Optionally, an administration time when one or more symptoms of a disease or condition are present, or conditions exist that such a symptom is expected or may occur. Optionally, administration is prior to, following, during, or in lieu of a meal, snack or other consumption of food or nutritious drink. Optionally, administration is prior to, during or following the consumption of alcohol. Optionally, an administration time is at the initiation of a work period.

[0085] Administration time is optionally from -4 hours to 12 hours following light exposure. Optionally, administration is from 0 to 12 hours after light exposure. Optionally, an administration time is upon waking independent of the time of day or the onset of light exposure. Optionally, an administration time is in the evening. The inventors have shown that administration of an effective amount of an extract of rosemary, an extract of *hemerocallis fulva*, or combinations thereof increases the expression of several proteins involved in several circadian processes. An administration time may be tailored to a desired time to have expression of such a protein or collection of proteins expressed to adjust the sleep-wake cycle of a subject, or to improve wakefulness at a desired time with the improvement in wakefulness optionally, not due to improved rest. In some aspects, the extract is administered in a form that releases at certain times, optionally in an extended release form, in a periodic release form, or using a time control pump.

[0086] In a typical regimen, the extract materials are taken orally between one and three times daily; although, other routes of administration may be utilized. Also, it should be noted that the extracts of the present invention may be utilized in the form of derivatives. For example, the extracts may be bonded, chemically or physically, to other species and moieties such as synthetic polymers, liposomes, small organic molecules, chitin, chitosan, other biopolymers and the like.

In view of the teaching presented herein, still further combinations will be readily apparent to those of skill in the art.

[0087] A subject is administered a composition in a dosage so that each dose of the extract supplement selected to deliver an amount of active agent suitable to have an effect on an expression characteristic of a circadian protein. Variable dosing regimens are operative. While in some instances, a single dose treatment may be effective in producing therapeutic effects, in other instances a treatment period in the range of, for example, six weeks to three or six months or more may be utilized. The composition may be administered orally, parentally, or intravenously, intramuscularly, intraperitoneally, by transdermal injection, or by contact with a cell or tissue such as by immersion or other form of contact. Injectables may be prepared in conventional forms, either liquid solutions or suspensions, solid forms suitable for solution or prior to injection, or as suspension in liquid prior to injection or as emulsions.

[0088] The extracts may be provided in sterile form and contain an effective amount of one or more agents for producing the desired response in a unit of weight or volume suitable for administration to a subject. The doses of extracts or dietary supplements containing gone or more of the extracts are administered to a subject can be chosen in accordance with different parameters in accordance with the mode of administration used and the state of the subject. Other factors include the desired period of treatment. In the event that a response in a subject is insufficient at the initial doses applied, higher doses (or effectively higher doses by a different, more localized delivery route) may be employed to the extent that patient tolerance permits. The dosage of a pharmacological agent may be adjusted by the individual physician or veterinarian, particularly in the event of any complication.

[0089] The dose of the composition may vary depending on the age, weight, general condition of the subject. For example, dosage is in the range of 1-1,000 mg of equivalent of dry extract powder extract per day may be an effective range. In some aspects, a dosage is between 10 and 800 mg per day, optionally from 100 to 600 mg per day, optionally 200-400 mg per day, optionally 400 mg per day. Dosage is optionally 1, 2, 3, 4, or more times daily. Optionally, dosage is twice daily. Optionally, dosage is 200 mg twice daily. The extract may also comprise 0.01%-100% of the dry weight of the composition. For example, a dietary supplement composition may comprise 20%-50% of the dry weight of the extract composition. An "effective amount" is defined as that capable of altering one or more expression characteristics of a circadian protein or a gene encoding a circadian protein relative to a control.

[0090] An extract optionally is or is a part of a dietary supplement composition. An extract is optionally present in a dietary supplement composition at 10%-100% by weight, optionally 20%-50% by weight, optionally 30%-40% by weight, or any value or range between 10% and 100% of the dry weight of the dietary supplement composition.

[0091] Various aspects of the present invention are illustrated by the following non-limiting examples. The examples are for illustrative purposes and are not a limitation on any practice of the present invention. It will be understood that variations and modifications can be made without departing from the spirit and scope of the invention.

EXPERIMENTAL

[0092] It was investigated whether an extract of rosemary (RME) and an extract of *hemerocallis fulva* (HFE) regulate key circadian protein expression in normal rat C6 glioma cells and IPEC-1 (Porcine intestinal epithelial cell lines), using immunofluorescence and western blotting analyses. Oxygen and circadian rhythmicity are essential in a myriad of physiological processes to maintain homeostasis, from blood pressure and sleep/wake cycles, down to cellular signaling pathways that play critical roles in health and disease. Oxidative stress can induce the dysregulated circadian rhythms. We also test if RME and HFE attenuate the damages of these proteins expression from oxygen-glucose deprivation (OGD).

[0093] The dried rosemary extract and *hemerocallis fulva* extract were provided by Integrity Nutraceuticals International (Spring Hill, TN, USA). The dried powder of each extract contains 25% ursolic acid. To obtain a more pure extract fraction, the dried rosemary or *Hemerocallis fulva* powder (1g) was incubated with an aqueous phosphate buffer solution 0.01 M, pH 7.4 (5mL), at 60°C for 4 hours, then centrifuged at 6000 rpm for 15 minutes. The supernatant was filtrated by 40 μm filter mesh and saved for the concentration evaluation. Aliquots of RME and HFE were prepared at 10 mg/mL and stored at −20°C for use in subsequent studies.

[0094] C6 glioma cells (CCL-107) were purchased from American Type Culture Collection (ATCC; Manassas, VA). Cell cultures were grown in F-12 K medium (Gibco/Invitrogen) supplemented with 10% horse serum and 2% fetal bovine serum and maintained at 37 °C with 5% CO_2/95% air. Cultures were grown to 85% confluency in 75 mm flasks and, after trypsinization, were seeded in 35 mm culture dishes or 6 well plates; and grown to confluence during the experimental period. All cultures were used in the experiments between passages 22 and 32. Plated cells were grown for 2 days before treatment with an extract or control.

[0095] Culture of IPEC-1 cells was carried out at 37°C in an atmosphere containing 5% CO_2. Undifferentiated IPEC-1 cells were maintained in serial passage in growth medium (GM): DMEM/F12 medium supplemented with 5% FBS, insulin, transferrin (ITS Premix), epidermal growth factor, penicillin and streptomycin. Cells were maintained in serum-containing GM for 48 h for the experiments.

[0096] The effects of the RME or HFE were studied in cells by staining for target proteins using the following primary antibodies all provided by Abcam Inc, Cambridge, MA. SIRT1 was detected by ab110304 Mouse monoclonal [19A7AB4]. KAT13D / CLOCK was detected using ab134165 Rabbit monoclonal [EPR6227]. BMAL1 was detected using the C-terminal recognizing antibody ab140646 Rabbit monoclonal [EPR8355(2)]. FBXL3 was detected using ab96645 Rabbit polyclonal. FBXL21 was detected using ab57302 Mouse monoclonal. For each immunofluorescence study the cells were stained with the primary antibody for the target of interest followed by incubation with AlexaFluor® 594-conjugated normal rabbit IgG (green) or AlexaFluor® 488-conjugated normal mouse IgG (red).

[0097] C6 cells were treated with saline with or without RME (20, 50 and 100μg/mL) or without HFE (50, 100 and 200μg/mL) in the medium for 2h at 37°C. The effects of rosemary extract (RME) and hemerocallis fulva extract (HFE) on circadian locomoter output cycles protein kaput (CLOCK) protein expression in C6 glioma cells are determined by immunofluorescence. A2h treatment with RME or HFE significantly induced increased the intensity of immunofluorescence of CLOCK compared with the controls indicating enhanced CLOCK protein expression.

[0098] Similar results of RME and HFE on CLOCK protein expression were observed in IPEC-1 cells. IPEC-1 cells were treated with saline with or without RME (20, 50 and 100μg/mL) or with or without HFE (50, 100 and 200μg/mL) in the medium for 6h at 37°C. 6h RME and HFE treatment significantly induced the intensity of immunofluorescence of CLOCK compared with the controls.

[0099] FIG. 1 illustrates the effects of RME and HFE on CLOCK (FIG. 1A) and BMAL1 (FIG. 1B) protein expression in C6 cells. C6 cells were treated with saline with or without RME (20 and 50 μg/mL) or with or without HFE (50 and 100 μg/mL) in the medium for 7h at 37°C. Representative immunoblots show increased expression in RME and HFE treated C6 cells.

[00100] Oxygen glucose deprivation (OGD) was induced in cultures as described by Panickar et al. (Panickar et al., 2009a). Briefly, cultures were washed twice with a balanced salt solution (BSS) with the following composition (in mM): NaCl 116, KCl 5.4, $CaCl_2$ 1.8, $MgSO_4$ 0.8, NaH_2PO_4 0.83, $NaHCO_3$ 24 and phenol red 0.001w/v; pH 7.4. Following washes, BSS was added to the cultures and placed in an airtight container (Billups chamber; Billups-Rothenberg Inc., Del Mar, CA) and continuously flushed with 95% N_2/5% CO_2 for 5 hr. Following the OGD, BSS was removed and normal media was added immediately afterwards.

[00101] Oxygen-glucose deprivation (OGD)-induced decreased CLOCK expression is reversed and further enhanced by RME and HFE in IPEC-1 cells. The RME and HFE were added to the media during 4hr OGD and added to normal media for other 3hr, immediately after the end of 4hr OGD at 37°C. Sample photomicrographs of CLOCK fluorescence after 4hr OGD and 3h reperfusion in normal control (CON), OGD, and OGD + two dosages RME or HFE 100 μg/ml or 200 μg/ml illustrate increases in CLOCK expression relative to control and OGD treated cells.

[00102] Immunofluorescence measurements demonstrated that RME and HFE each increased FBXL3 protein levels in 4hr oxygen-glucose deprivation (OGD) and 2hr reperfusion treated C6 glioma cells. The RME or HFE were added to the media during 4hr OGD and added to normal media for other 2hr, immediately after the end of 4hr OGD at 37°C. Sample photomicrographs of FBXL3 fluorescence after 4hr OGD and 2h reperfusion in OGD, and OGD + two dosages RME and HFE 50 μg/ml or 100 μg/ml illustrate enhanced expression of FBXL3 due to the presence of the extract.

[00103] RME (A) and HFE (B) both increased FBXL3 protein levels in 4hr oxygen-glucose deprivation (OGD) and 2hr reperfusion treated IPEC-1 cells as illustrated by immunofluorescence. The RME and HFE were added to the media during 4hr OGD and added to normal media for other 3hr, immediately after the end of 4hr OGD at 37°C. Sample photomicrographs of FBXL3 fluorescence after 4hr OGD and 3h reperfusion in OGD, and OGD + RME or HFE at either 50 μg/ml or 100 μg/ml demonstrate enhanced expression of FBXL3 protein due to extract exposure.

[00104] FIG. 2 illustrates RME increased BMAL1 (A) and FBXL21 (B) protein levels in 4hr oxygen-glucose deprivation (OGD) and 2hr reperfusion treated C6 cells. The RME was added to the media during 4hr OGD and added to normal media for other 2hr, immediately after the end

of 4hr OGD at 37°C. The blot bands are detected by Odyssey® Western Blotting. Briefly, the blot was probed with rabbit anti-BMAL1 or mouse anti-FBXl21 followed by detection with IRDye® 800CW Goat anti-Rabbit IgG (LI-COR P/N 926-32231) or IRDye 680RD Goat anti-Mouse IgG (LI-COR P/N 926-68070). Sample photomicrographs of FBXL21 fluorescence after 4hr OGD and 2h reperfusion in OGD, and OGD + two dosages RME are illustrated.

[00105] The effects of RME or HFE on SIRT1 protein expression in 4hr oxygen-glucose deprivation (OGD) and 2hr reperfusion treated C6 cells were examined by immunofluorescence. The RME or HFE were added to the media during 4hr OGD and added to normal media for other 2hr, immediately after the end of OGD at 37°C. SIRT1 fluorescence was increased in RME and HFE at either 50 μg/ml or 100 μg/ml in 4hr OGD and 2hr reperfusion treated C6 cells.

[00106] Rat L-6 myogenic cell line (ATCC) were grown as a monolayer in DMEM with 10% fetal bovine serum (FBS) at 37°C in a humidified incubator with 5% CO_2. L-6 cells ($0.5x10^6$) were seeded on 6-well plates. Experiments were initiated 48 hr after plating. For oxygen-glucose deprivation (OGD) of the L-6 cells, the culture media was replaced with hypoglycemic media and placed in an airtight Billups chamber and flushed with 95%N_2/5%CO_2 for 4 hr. Following OGD treatment, hypoglycemic media was replaced with regular media and returned to the incubator, with or without RME, HFE or the mixture of RME/HFE for 20hr. After treatment, the cells were washed twice with cold PBS, and harvested by scraping in 200 μl of lysis buffer. Eighty micrograms of protein, which was determined by Bradford assay (Bio-Rad protein assay kit) was separated electrophoretically using a 10% sodium dodecyl sulfatepolyacrylamide gel electrophoresis gel and transferred to a nitrocellulose membrane. The membrane was incubated at room temperature in Odyssey blocking buffer including 0.05% Tween-20 containing primary antibodies as above directed to one of the following: SIRT1 (1:500), CLOCK (1:2000), Bmal1 (1:1000), or β-actin (1:1000). After washing with TBS-T three times, the membrane was incubated with anti-mouse or rabbit IRDye secondary antibodies (1:10,000) for 1 h at room temperature. Quantitative IR western blot detection was performed with Odyssey CLx Imager. Data were analyzed by one-way analysis of variance followed by post-hoc analysis of between group mean differences by Fisher's Least Significant Difference (LSD) test. Different superscripts indicate significant differences among groups ($p < 0.05$).

[00107] As illustrated in FIG. 3A, SIRT1 levels are increased in OGD treated L-6 cells by RME and/or HFE. The quantified amounts of protein are illustrated in FIG. 3B demonstrating significantly increased amounts of SIRT1 levels relative to control. An additional effect is

observed in RME+HFE mixture treated cells on SIRT1 expression, compared with individual RME or HFE only treated cells.

[00108] FIG. 4 illustrates CLOCK protein levels increased in OGD treated L-6 cells by RME and/or HFE. RME, HFE, or both significantly enhance CLOCK protein expression in OGD treated L6 skeletal muscle cells. An additional effect in RME+HFE mixture treated cells on CLOCK expression is also observed compared to individual RME or HFE only treated cells.

[00109] FIG. 5 illustrates Bmal1 protein levels increased in OGD treated L-6 cells by RME and/or HFE. RME, HFE, or both significantly enhance Bmal1 protein expression in OGD treated L-6 skeletal muscle cells. An additional effect is observed in cells treated with the RME+HFE compared with individual RME or HFE only treated cells.

[00110] Overall, a method for regulating expression of five key proteins linked to circadian rhythm disorders (CLOCK, BMAL1, FBXL3, FBXL21 and SIRT1) is described characterized by modulating expression in normal conditions and oxidative stress conditions in Rat Cr brain glioma cells, Rat L-6 myogenic cells, and IPEC-2 cells. Both extracts, RME and HFE, each significantly modulate the expression of circadian clock proteins in all cell types, and reverse cell damages identified by redcutions of the key proteins related to circadian rhythms induced by oxidative stress. These results indicate that RME and HFE extracts are useful as a new approach to attenuate the disruption of circadian rhythms, or to modulate circadian rhythm in a subject.

Ursolic acid enhances the expression of circadian rhythm proteins

[00111] iPEC-1 cells were grown as a monolayer in DMEM with 10% fetal bovine serum (FBS) and the necessary supplements at 37°C in a humidified incubator with 5% CO_2. iPEC1 cells were seeded on 35 mm dishes. Experiments were initiated 48 hr after plating. Cells were treated with saline or with ursolic acid at three separate dosages (1 μM; 5 μM; or 20 μM) in the medium for 24 hr at 37°C. The cells were then washed with ice-cold PBS and fixed with 4% paraformaldehyde for 10 min at room temperature followed by permeabilization with 0.3% Triton X-100 for 10 min. After being washed with PBS three times, cells were incubated for 1 hr in PBS containing 10% normal goat serum blocking solution. The cells were subjected to immunofluorescence staining with the target specific antibodies (SIRT1, CLOCK and Bmal1) overnight at 4°C. The cells were then washed with cold PBS three times for 3 min each, and incubated with Alexa-labeled secondary antibodies (Invitrogen) at room temperature for 1 h. The

cells were examined by fluorescence microscopy (a Nikon TE2000-S microscope, Nikon, Tokyo, Japan).

[00112] 24 hour incubation with ursolic acid significantly induced the intensity of immunofluorescence of SIRT1, CLOCK and Bmal1 compared with controls at all three concentrations of ursolic acid tested as evidenced by immunofluorescence staining.

[00113] Scientific and technical terms used herein are intended to have the meanings commonly understood by those of ordinary skill in the art. Such terms are found defined and used in context in various standard references illustratively including J. Sambrook and D.W. Russell, Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press; 3rd Ed., 2001; F.M. Ausubel, Ed., Short Protocols in Molecular Biology, Current Protocols; 5th Ed., 2002; B. Alberts et al., Molecular Biology of the Cell, 4th Ed., Garland, 2002; D.L. Nelson and M.M. Cox, Lehninger Principles of Biochemistry, 4th Ed., W.H. Freeman & Company, 2004; Wild, D., The Immunoassay Handbook, 3rd Ed., Elsevier Science, 2005; Gosling, J. P., Immunoassays: A Practical Approach, Practical Approach Series, Oxford University Press, 2005;Antibody Engineering, Kontermann, R. and Dübel, S. (Eds.), Springer, 2001; Harlow, E. and Lane, D., Antibodies: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 1988; Ausubel, F. et al., (Eds.), Short Protocols in Molecular Biology, Wiley, 2002; J. D. Pound (Ed.) Immunochemical Protocols, Methods in Molecular Biology, Humana Press; 2nd ed., 1998; B.K.C. Lo (Ed.), Antibody Engineering: Methods and Protocols, Methods in Molecular Biology, Humana Press, 2003; and Kohler, G. and Milstein, C., Nature, 256:495-497 (1975); the contents of each of which are incorporated herein by reference.

[00114] Methods involving conventional biological techniques are described herein. Such techniques are generally known in the art and are described in detail in methodology treatises such as Molecular Cloning: A Laboratory Manual, 3rd ed., vol. 1-3, ed. Sambrook et al., Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., 2001; Current Protocols in Molecular Biology, ed. Ausubel et al., Greene Publishing and Wiley-Interscience, New York, 1992 (with periodic updates); and Short Protocols in Molecular Biology, ed. Ausubel et al., 52 ed., Wiley-Interscience, New York, 2002. Immunological methods (e.g., preparation of antigen-specific antibodies, immunoprecipitation, and immunoblotting) are described, e.g., in Current Protocols in Immunology, ed. Coligan et al., John Wiley & Sons, New York, 1991; and Methods of Immunological Analysis, ed. Masseyeff et al., John Wiley & Sons, New York, 1992.

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22. WO 2001/080818 A1

[00115] Various modifications of the present invention, in addition to those shown and described herein, will be apparent to those skilled in the art of the above description. Such modifications are also intended to fall within the scope of the appended claims.

[00116] It is appreciated that all reagents are obtainable by sources known in the art unless otherwise specified.

[00117] Patents, publications, and applications mentioned in the specification are indicative of the levels of those skilled in the art to which the invention pertains. These patents, publications, and applications are incorporated herein by reference to the same extent as if each individual patent, publication, or application was specifically and individually incorporated herein by reference.

[00118] The foregoing description is illustrative of particular aspects of the invention, but is not meant to be a limitation upon the practice thereof. The following claims, including all equivalents thereof, are intended to define the scope of the invention.

CLAIMS

1. A composition for the treatment or prevention of a disease or condition related to the expression of a circadian rhythm related protein comprising:

an effective amount of an extract of rosemary, an extract of *hemerocallis fulva*, active portion or component thereof, or combinations thereof, said extract formulated for administering to a subject in need of treatment of a disease or condition related to a circadian rhythm; and

ameliorating, preventing, or modulating a symptom of said disease or condition in said subject whereby said effective amount is sufficient to alter one or more expression characteristics of a protein selected from the group consisting of CLOCK, BMAL1, FBXL3, FBXL21, SIRT1, or combinations thereof, in said subject.

2. The composition of claim 1 wherein said extract is a water extract.

3. The composition of claim 1 wherein extract is a component in a dietary supplement.

4. The composition of claim 1 wherein said administering is once daily.

5. The composition of claim 1 wherein said extract is an extract of rosemary and said protein is the BMAL1 protein.

6. The composition of claim 1 wherein said extract is an extract of rosemary and said protein is FBXL3, FBXL21, or combinations thereof.

7. The composition of claim 1 wherein said extract is an extract of rosemary and said protein is SIRT1.

8. The composition of claim 1 wherein said extract is an extract of *hemerocallis fulva* and said protein is CLOCK.

9. The composition of claim 1 wherein said extract is an extract of *hemerocallis fulva* and said protein is BMAL1.

10. The composition of claim 1 wherein said extract is an extract of *hemerocallis fulva* and said protein is FBXL3, FBXL21, or combinations thereof.

11. The composition of claim 1 wherein said extract is an extract of *hemerocallis fulva* and said protein is SIRT1.

12. The composition of any one of claims 1-11 wherein said disease or condition is jet lag.

13. The composition of claim 12 wherein said administration is prior to or following travel involving a change in time zone.

14. The composition of any one of claims 1-11 wherein said disease or condition is a hangover.

15. The composition of claim 14 wherein said extract is administered prior to, during, or following the consumption of alcohol, or combinations thereof.

16. The composition of any one of claims 1-11 wherein said disease or condition is a metabolic condition related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, or SIRT1.

18. The composition of claim 16 wherein said metabolic conditions is abnormal cholesterol level, obesity, metabolic syndrome or element thereof, hyperglycemia, hypoglycemia, abnormal insulin production, or diabetes.

19. The composition of any one of claims 1-11 wherein said disease or condition is an inflammatory disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

20. The composition of any one of claims 1-11 wherein said disease or condition is a neurological disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

21. The composition of claim 20 wherein said neurological disorder is Alzheimer's disease.

22. The composition of any one of claims 1-11 wherein said disease or condition is a muscular disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

23. The composition of claim 22 wherein said muscular disorder is muscular dystrophy or myopathy.

24. The composition of any one of claims 1-11 wherein said disease or condition is a sleep disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

25. The composition of claim 24 wherein said sleep disorder is insomnia, jet lag, shift work sleep disorder, delayed sleep phase syndrome (DSPS), advanced sleep phase syndrome (ASPS), non 24-hour sleep wake disorder or irregular sleep-wake pattern.

26. The composition of claim 25 wherein said administration is from -4 hours to 12 hours or 0 to 12 hours after light exposure.

27. The composition of claim 25 wherein said administration is from 1-3 hours after light exposure or 10-14 hours after light exposure.

28. The composition of claim 25 wherein said administration is from 4 hours to 0 hours prior to light exposure.

29. The composition of any one of claims 1-11 wherein said disease or condition is a psychiatric disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

30. The composition of claim 29 wherein said psychiatric disorder is depression, seasonal affective disorder, dementia, or rapid-cycling bipolar disorder.

31. The composition of any one of claims 1-11 wherein said disease or condition is a cardiovascular disorder related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

32. The composition of claim 31 wherein said cardiovascular disorder is abnormal blood pressure or abnormal heart rate.

33. The composition of claim 31 wherein said cardiovascular disorder is atherosclerosis or cardiomyopathy.

34. The composition of any one of claims 1-11 wherein said disease or condition is a liver toxicity related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

35. The composition of any one of claims 1-11 wherein said disease or condition is a disorder of the brain related to an expression characteristic of one or more of CLOCK, BMAL1, FBXL3, FBXL21, of SIRT1.

36. The composition of claim 35 wherein said disorder of the brain is stroke or brain degeneration due to free radicals.

37. The composition of any one of claims 1-11 wherein said composition is administered on an as needed basis.

38. The composition of any one of claims 1-11 wherein said protein is not SIRT1.

39. The composition of any one of claims 1-11 wherein said extract comprises ursolic acid at 10% by weight or greater.

40. The composition of any one of claims 1-11 wherein said extract comprises ursolic acid at 25% by weight or greater.

41. The composition of any one of claims 1-11 wherein said extract consists of ursolic acid.

42. The composition of any one of claims 1-11 wherein said administration is for a period of 2 weeks or more.

43. The composition of any one of claims 1-11 wherein said administration is for four weeks or more.

44. The composition of any one of claims 1-11 wherein said administration is for three months or more.

45. The composition of any one of claims 1-11 wherein said administration is once, twice, three, or four times daily.

46. The composition of claim 3 wherein said dietary supplement is in the form of a powder, gel, liquid, food, solid, or other form.

47. A composition for treating or preventing obesity in a subject in need thereof comprising:

an extract of rosemary, an extract of *hemerocallis fulva*, active portion or component thereof, or combinations thereof, said extract for administration to a subject in need of treatment or prevention of obesity;

said obesity related to an expression characteristic or CLOCK, BMAL1, FBXL3, FBXL21, SIRT1, or combinations thereof;

and ameliorating, preventing, or modulating obesity in said subject whereby said effective amount is sufficient to alter one or more expression characteristics of a protein selected from the group consisting of CLOCK, BMAL1, FBXL3, FBXL21, SIRT1, or combinations thereof, in said subject.

48. A composition for treating or preventing cancer in a subject in need thereof comprising:

an extract of rosemary, an extract of *hemerocallis fulva*, active portion or component thereof, or combinations thereof, said extract for administration to a subject in need of treatment or prevention of cancer;

said cancer related to an expression characteristic or CLOCK, BMAL1, FBXL3, FBXL21, SIRT1, or combinations thereof;

and ameliorating, preventing, or modulating cancer in said subject whereby said effective amount is sufficient to alter one or more expression characteristics of a protein selected from the group consisting of CLOCK, BMAL1, FBXL3, FBXL21, SIRT1, or combinations thereof, in said subject.

49. A process substantially as described in the specification.

50. A composition substantially as described in the specification.


CLOCK
CON
RME 20
50
HFE 50
100 (μg/mL)

FIG. 1A


Bmal1
CON
RME 20
50
HFE 50
100 (μg/mL)

FIG. 1B

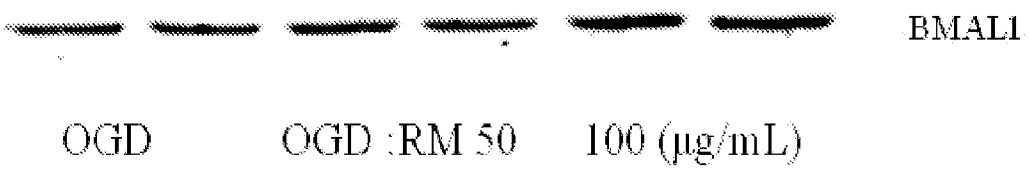


FIG. 2A

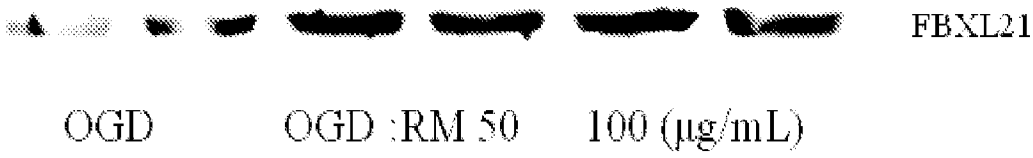
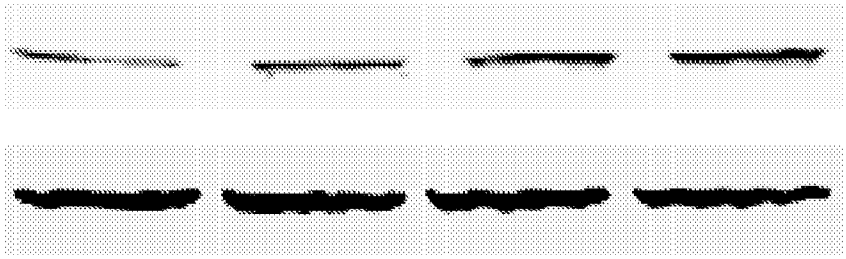
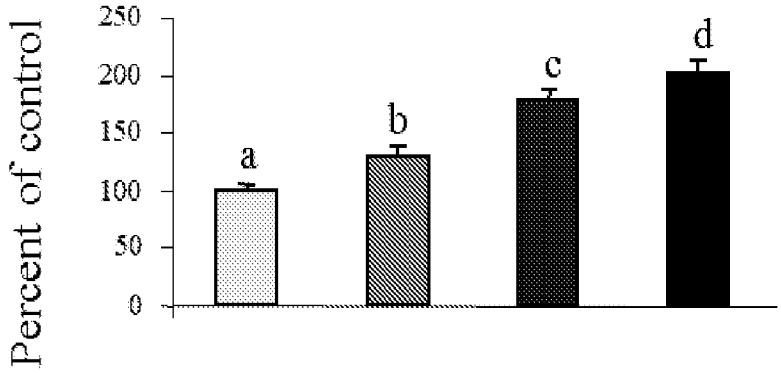


FIG. 2B



OGD: CON RE (20μg/mL) HE (20μg/mL) RE+HE (20μg/mL, each)

FIG. 3A

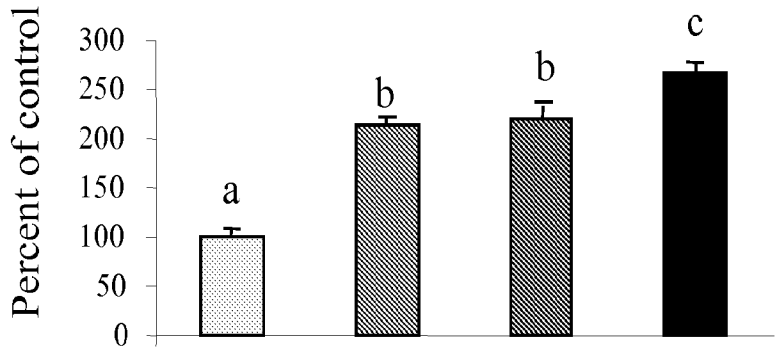


OGD: CON RE (20μg/mL) HE (20μg/mL) RE+HE (20μg/mL, each)

FIG. 3B

OGD: CON RE (20μg/mL) HE (20μg/mL) RE+HE (20μg/mL, each)

FIG. 4A

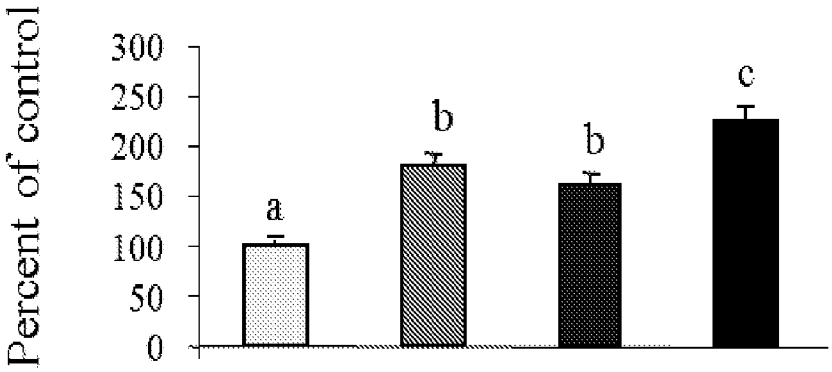


OGD: CON RE (20μg/mL) HE (20μg/mL) RE+HE (20μg/mL, each)

FIG. 4B

OGD: CON RE (20μg/mL) HE (20μg/mL) RE+HE (20μg/mL, each)

FIG. 5A



OGD: CON RE (20μg/mL) HE (20μg/mL) RE+HE (20μg/mL, each)

FIG. 5B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/65374

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61K 36/53, 36/896 (2015.01)
CPC - A61K 36/53, 36/896; A23L 1/3002
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)
IPC(8): A61K 36/00, 36/53, 36/896; C07C 15/20, 63/44 (2015.01); CPC: A61K 36/53, 36/896, 36/00; C07C 15/20, 63/44; A23L 1/3002; USPC: 424/725, 745, 762, 763, 764, 765, 766

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)
Patseer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC); Proquest Dialog; Pubmed/Pubmed Central; Google/Google Scholar: 'Circadian rhythm', 'circadian clock', rosemary, 'rosmarinus officinalis', 'Hemerocallis fulva', daylily, CLOCK, BMAL1, FBXL3, FBXL21, SIRT1, extract, 'essential oil', treatment, pharmaceutical, therapy, gene, protein, 'Sirtuin 1', ARNTL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- A	TU, Z et al. Rosemary (Rosmarinus officinalis L.) Extract Regulates Glucose and Lipid Metabolism by Activating AMPK and PPAR Pathways in HepG2 Cells. J Agric Food Chem. 20 March 2013, Vol. 61, No. 11, pp. 2803-2810; abstract; page 2803, second column, third paragraph to page 2804, first column, third paragraph; page 2805, second column, third paragraph to page 2806, first column, first paragraph; page 2808, first column, first paragraph; Figure 3; DOI: 10.1021/jf400298c	47 --- 1-16, 18-46, 48
A	US 2011/0076349 A1 (YOSHIHARA, K. et al.) March 31, 2011; paragraphs [0053]-[0056], [0122]-[0129]	1-16, 18-46, 48
A	US 2010/0028317 A1 (MAES, DH et al.) February 4, 2010; paragraphs [0034]-[0046]	1-16, 18-46, 48
A	KANESHIRO, T. et al. Growth Inhibitory Activities of Crude Extracts Obtained from Herbal Plants in the Ryukyu Islands on Several Human Colon Carcinoma Cell Lines. Asian Pac J Cancer Prev. September 2005, Vol. 6, No. 3, pp. 353-358; page 355, first column, third paragraph to page 356, first column, first paragraph; PMID: 16235999	48
A	YESIL-CELIKTAS, O. et al. Inhibitory Effects of Rosemary Extracts, Carnosic Acid and Rosmarinic Acid on the Growth of Various Human Cancer Cell Lines. Plant Foods Hum Nutr. June 2010, Vol. 65, No. 2, pp. 158-163; abstract; DOI: 10.1007/s11130-010-0166-4	48
A	UEZU, E. Sleep-wake Regulation, Effects of Hemerocallis on Sleep in Mice. Psychiatry Clin Neurosci. April 1998, Vol. 52, No. 2, pp. 136-137; DOI: 10.1111/j.1440-1819.1998.tb00992.x	1-16, 18-48
A	US 2013/0022635 A1 (GOZU, Y et al.) January 24, 2013; abstract	1-16, 18-48

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 February 2015 (03.02.2015)	24 FEB 2015
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/65374

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 49 and 50
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 49 and 50 are improper unsearchable omnibus-type claims.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.