previously unobservable by standard methods for monitoring color intensity of the formulated product.

[0005] Oxidation is a major chemical degradation pathway for protein pharmaceuticals. For example, methionine, cysteine, histidine, tryptophan, and tyrosine are amino acid residues that are susceptible to oxidation due to their reactivity with reactive oxygen species (ROS) and this oxidation is often observed in pharmaceutical protein formulations during storage. Although it is known that cell culture conditions can impact quality attributes of the protein product, such as production of sufficient amounts for large-scale manufacturing, the impact of these conditions on the color intensity of the final protein product remains unclear.

[0006] There is a continuing need to provide improved and cost-effective methods of producing proteins (*e.g.*, antibodies) having acceptable product quality attributes such as color intensity. Cell culture media, whether chemically undefined or chemically defined, having components that consistently deliver protein products at lower color intensities while maintaining a desired protein concentration (*e.g.*, $\geq$ 100 mg/mL) would find use in the development of protein products, such as antibodies.

~~BRIEF~~ SUMMARY ~~OF THE INVENTION~~

[0007] In ~~some~~ one aspect~~s~~, there ~~invention herein~~is provide~~s~~d a method of culturing a cell comprising a nucleic acid encoding a polypeptide, wherein the method comprises the step of contacting the cell with a cell culture medium comprising hypotaurine or an analog or precursor thereof, wherein the cell culture medium comprising the hypotaurine or an analog of precursor thereof reduces the color intensity of a composition comprising the polypeptide produced by the cell as compared to the color intensity of a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the hypotaurine or an analog or precursor thereof. In some embodiments, the cell culture medium comprising the hypotaurine or an analog or precursor thereof reduces the color intensity of a composition comprising the polypeptide produced by the cell by at least about 0.1% as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the hypotaurine or an analog or precursor thereof. In some embodiments, the cell culture medium comprising the hypotaurine or an analog or precursor thereof reduces the color intensity of a composition comprising the polypeptide produced by the cell by about 5% to about 50% as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the hypotaurine or an analog or precursor thereof. In some of the embodiments

herein, the cell culture medium comprises the hypotaurine or an analog or precursor thereof at a concentration of at least about 0.0001 mM. In some of the embodiments herein, the cell culture medium comprises the hypotaurine or an analog or precursor thereof at a concentration from about 0.0001 mM to about 500.0 mM. In some of the embodiments herein, the cell culture medium comprises the hypotaurine or an analog or precursor thereof at a concentration from about 1.0 mM to about 40.0 mM. In some of the embodiments herein, the cell culture medium comprises the hypotaurine or an analog or precursor thereof at a concentration from about 1.0 mM to about 10.0 mM. In some of the embodiments herein, the hypotaurine or an analog or precursor thereof is selected from the group consisting of hypotaurine, s-carboxymethylcysteine, cysteamine, cysteinesulphinic acid, and taurine. In some of the embodiments herein, the cell culture medium comprising the hypotaurine or an analog or precursor thereof is a chemically defined cell culture medium. In some of the embodiments herein, the cell culture medium comprising the hypotaurine or an analog or precursor thereof is a chemically undefined cell culture medium. In some of the embodiments herein, the cell culture medium comprising the hypotaurine or an analog or precursor thereof is a basal cell culture medium. In some of the embodiments herein, the cell culture medium comprising the hypotaurine or an analog or precursor thereof is a feed cell culture medium. In some of the embodiments herein, the cell is contacted with the cell culture medium comprising the hypotaurine or an analog or precursor thereof during the cell's growth phase. In some of the embodiments herein, the cell is contacted with the cell culture medium comprising the hypotaurine or an analog or precursor thereof during the cell's production phase. In some of the embodiments herein, the hypotaurine or an analog or precursor thereof is added to the cell culture medium on at least one day of a cell culture cycle. In some of the embodiments herein, the hypotaurine or an analog or precursor thereof is added to the cell culture medium on day 0 of a 14 day cell culture cycle. In any of the embodiments herein, the hypotaurine or an analog or precursor thereof can be added to the cell culture medium on any day of a cell culture cycle. In some of the embodiments herein, the cell is a mammalian cell. In some of the embodiments herein, the mammalian cell is a Chinese Hamster Ovary (CHO) cell. In some of the embodiments herein, the polypeptide is an antibody or fragment thereof.

[0008] In other aspects, there ~~invention hereinare~~ provided methods of culturing a cell comprising a nucleic acid encoding a polypeptide, wherein the method comprises the step of contacting the cell with a cell culture medium, wherein the cell culture medium comprises one or more of components (a)-(h): (a) hypotaurine; (b) s-carboxymethylcysteine; (c)

mM to about 0.040 mM. In some of the embodiments herein, the cell culture medium comprises lipoic acid at a concentration from about 0.040 mM to about 0.060 mM. In some of the embodiments herein, the cell culture medium comprises quercitrin hydrate at a concentration from about 0.010 mM to about 0.020 mM. In some embodiments, the cell culture medium comprises aminoguanidine at a concentration from about 0.0003 mM to about 245 mM. In some embodiments, the cell culture medium comprises aminoguanidine at a concentration from about 0.0003 mM to about 10 mM. In some of the embodiments herein, the cell culture medium is a chemically defined cell culture medium. In some of the embodiments herein, the cell culture medium is a chemically undefined cell culture medium. In some of the embodiments herein, the cell culture medium is a basal cell culture medium. In some of the embodiments herein, the cell culture medium is a feed cell culture medium. In some of the embodiments herein, the cell is contacted with the cell culture medium during the cell's growth phase. In some of the embodiments herein, the cell is contacted with the cell culture medium during the cell's production phase. In some of the embodiments herein, the one or more of components (a)-(h) is added to the cell culture medium on at least one day of a cell culture cycle. In some of the embodiments herein, the one or more of components (a)-(h) is added to the cell culture medium on day 0 of a 14 day cell culture cycle. In any of the embodiments herein, the one or more of components (a)-(h) can be added to the cell culture medium on any day of a cell culture cycle. In some of the embodiments herein, wherein the cell is a mammalian cell. In some of the embodiments herein, wherein the mammalian cell is a Chinese Hamster Ovary (CHO) cell. In some of the embodiments herein, wherein the polypeptide is an antibody or fragment thereof.

[0009] In some aspects, there ~~invention hereinare~~ also provide~~sd~~ method~~s~~ of producing a polypeptide comprising the step of culturing a cell comprising a nucleic acid encoding the polypeptide in a cell culture medium comprising hypotaurine or an analog or precursor thereof, and wherein the cell culture medium comprising the hypotaurine or an analog or precursor thereof reduces the color intensity of a composition comprising the polypeptide produced by the cell as compared to the color intensity of a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the hypotaurine or an analog or precursor thereof. In some embodiments, the cell culture medium comprising the hypotaurine or an analog or precursor thereof reduces the color intensity of a composition comprising the polypeptide produced by the cell by at least about 0.1% as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the hypotaurine or an analog or precursor thereof. In

composition comprising the recovered polypeptide appears as a colorless or slightly colored liquid.

[0010] In ~~some~~ another aspects, there ~~invention~~ is provided a method of producing a polypeptide comprising the step of culturing a cell comprising a nucleic acid encoding the polypeptide in a cell culture medium, wherein the cell culture medium comprises one or more of components (a)-(h): (a) hypotaurine; (b) s-carboxymethylcysteine; (c) carnosine; (d) anserine; (e) butylated hydroxyanisole; (f) lipoic acid; (g) quercitrin hydrate; and (h) aminoguanidine; and wherein the cell culture medium comprising one or more of components (a)-(h) reduces the color intensity of a composition comprising the polypeptide produced by the cell as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise one or more of components (a)-(h). In some embodiments, the cell culture medium comprising one or more of components (a)-(h) reduces the color intensity of a composition comprising the polypeptide produced by the cells by at least about 0.1% as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the one or more of components (a)-(h). In some embodiments, the cell culture medium comprising one or more of components (a)-(h) reduces the color intensity of a composition comprising the polypeptide produced by the cells by about 5% to about 50% as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the one or more of components (a)-(h). In some embodiments, the cell culture medium comprising one or more of components (a)-(h) reduces the color intensity of a composition comprising the polypeptide produced by the cells by about 5% to about 75% as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the one or more of components (a)-(h). In some of the embodiments herein, the cell culture medium comprises the one or more components (a)-(h) in an amount selected from: (a) hypotaurine at a concentration from at least about 0.0001 mM; (b) s-carboxymethylcysteine at a concentration from at least about 0.0001 mM; (c) carnosine at a concentration from at least about 0.0001 mM; (d) anserine at a concentration from at least about 0.0001 mM; (e) butylated hydroxyanisole at a concentration from at least about 0.0001 mM; (f) lipoic acid at a concentration from at least about 0.0001 mM; (g) quercitrin hydrate at a concentration from at least about 0.0001 mM; and (h) aminoguanidine at a concentration from at least about 0.0003 mM. In some embodiments, the cell culture medium comprises hypotaurine at a concentration from about 2.0 mM to about 50.0 mM. In some of the embodiments herein, the cell culture medium comprises s-carboxymethylcysteine

[0011] In one aspect, there is provided a polypeptide produced by any of the methods described herein. In ~~some-~~one aspects, there ~~invention-~~is providesd a pharmaceutical composition comprising a polypeptide produced by any of the methods described herein and a pharmaceutically acceptable carrier.

[0012] In ~~some-~~one aspects, there ~~invention-~~is providesd a kit for supplementing a cell culture medium with chemically defined constituents, the kit comprising hypotaurine or an analog or precursor thereof at a concentration of at least about 0.0001 mM, and wherein the hypotaurine or an analog or precursor is selected from the group consisting of hypotaurine, s-carboxymethylcysteine, cysteamine, cysteinesulphinic acid, and taurine.

[0013] In another aspects, there ~~invention-~~is also providesd a kit for supplementing a cell culture medium with chemically defined constituents, the kit comprising one or more of: (a) hypotaurine in an amount to provide from at least about 0.0001 mM hypotaurine in the cell culture medium; (b) s-carboxymethylcysteine in an amount to provide from at least about 0.0001 mM s-carboxymethylcysteine in the cell culture medium; (c) carnosine in an amount to provide from at least about 0.0001 mM carnosine in the cell culture medium; (d) anserine in an amount to provide from at least about 0.0001 mM anserine in the cell culture medium; (e) butylated hydroxyanisole in an amount to provide from at least about 0.0001 mM butylated hydroxyanisole; (f) lipoic acid in an amount to provide from at least about 0.0001 mM lipoic acid in the cell culture medium; (g) quercitrin hydrate in an amount to provide from at least about 0.0001 mM quercitrin hydrate in the cell culture medium; and (h) aminoguanidine in an amount to provide from at least about 0.0003 mM aminoguanidine in the cell culture medium.

[0014] In ~~some-~~one aspects, there ~~invention-herein~~is providesd a cell culture medium comprising from at least about 0.0001 mM of hypotaurine or an analog or precursor thereof selected from the group consisting of hypotaurine, s-carboxymethylcysteine, cysteamine, cysteinesulphinic acid, and taurine.

[0015] In other aspects ~~of the invention~~, provided herein is a cell culture medium comprising one or more of components (a)-(h): (a) from at least about 0.0001 mM hypotaurine; (b) from at least about 0.0001 mM s-carboxymethylcysteine; (c) from at least about 0.0001 mM carnosine; (d) from at least about 0.0001 mM anserine; (e) from at least about 0.0001 mM butylated hydroxyanisole; (f) from at least about 0.0001 mM lipoic acid; (g) from at least about 0.0001 mM quercitrin hydrate; and (h) from at least about 0.0003 mM aminoguanidine.

[0016] In ~~some~~ one aspects, the~~re invention herein~~is provide~~sd~~ a composition comprising (a) a cell comprising a nucleic acid encoding a polypeptide; and (b) any cell culture medium described herein.

[0017] In some aspects ~~of the invention~~, provided herein is a composition comprising: (a) a polypeptide; and (b) any cell culture medium described herein. In some embodiments, the polypeptide is secreted into the cell culture medium by a cell comprising a nucleic acid encoding the polypeptide.

[0018] The specification is considered to be sufficient to enable one skilled in the art to practice the ~~invention~~disclosure. Various modifications of the disclosure~~invention~~ in addition to those shown and described herein will become apparent to those skilled in the art from the foregoing description and fall within the scope of the appended claims. All publications, patents, and patent applications cited herein are hereby incorporated by reference in their entirety for all purposes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] **Figure 1** is a graph of representative compounds screened for impact on color intensity in a representative cell culture medium containing an antibody. Numerical results were normalized to the positive control where the value for the positive control was set at 0% change in color intensity. Values higher than 0% indicate increased color intensity. Values lower than 0% indicate reduced color intensity.

[0020] **Figure 2** is a subplot of Figure 1 showing compounds that reduced color intensity in a representative cell culture medium containing an antibody. Numerical results were normalized to the positive control where the value for the positive control was set at 0% change in color intensity. Values lower than 0% indicate reduced color intensity.

[0021] **Figure 3** is a series of graphs showing that a shaker flask cell culture model is comparable to the corresponding larger scale 2L cell culture model. **A)** Cell growth in culture over the duration of incubation as measured by viable cell density (VCC) and expressed as number of cells per cell culture volume. **B)** Cell viability in cell culture over the duration of incubation as measured by the number of viable cells as a percentage of the total number of cells. **C)** Antibody production in cell culture over the duration of incubation as measured by high performance liquid chromatography and expressed as antibody titer. SF indicates shaker flask cell culture model. 2L indicates a larger scale cell culture model.

CLAIMS

1. A method of culturing a cell comprising a nucleic acid encoding a polypeptide, wherein the method comprises the step of contacting the cell with a cell culture medium comprising hypotaurine or an analog or precursor thereof, wherein the cell culture medium comprising the hypotaurine or an analog ~~of~~ or precursor thereof reduces the color intensity of a composition comprising the polypeptide produced by the cell as compared to the color intensity of a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the hypotaurine or an analog or precursor thereof.

2. The method of claim 1, wherein the cell culture medium comprising the hypotaurine or an analog or precursor thereof reduces the color intensity of a composition comprising the polypeptide produced by the cell by at least about 0.1% as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the hypotaurine or an analog or precursor thereof.

3. The method of claim 1, wherein the cell culture medium comprising the hypotaurine or an analog or precursor thereof reduces the color intensity of a composition comprising the polypeptide produced by the cell by about 5% to about 50% as compared to a composition comprising the polypeptide produced by the cell cultured in a cell culture medium that does not comprise the hypotaurine or an analog or precursor thereof.

4. The method of any one of claims 1-3, wherein the cell culture medium comprises the hypotaurine or an analog or precursor thereof at a concentration of at least about 0.0001 mM.

5. The method of claim 4, wherein the cell culture medium comprises the hypotaurine or an analog or precursor thereof at a concentration from about 0.0001 mM to about 500.0 mM.

6. The method of claim 4, wherein the cell culture medium comprises the hypotaurine or an analog or precursor thereof at a concentration from about 1.0 mM to about 40.0 mM.