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(54) Title: AN ANTI-LEUKEMIC AGENT USEFUL FOR INDUCING DIFFERENTIATION IN MYELOID LEUKEMIA CELLS

(57) Abstract: The present invention provides the compound Ormeloxifene [3, 4-trans-2,2-dimethyl-3-phenyl-4-p- (beta-pyrrolidinoethoxy) phenyl-7-methoxy chroman] as useful in inducing differentiation in wide range of myeloid leukemias including acute promyelocytic leukemia, acute myeloid leukemia and chronic myeloid leukemia where block in differentiation is common feature. Ormeloxifene induced differentiation that is marked by increase in differentiation marker proteins like C/EBPa and surface proteins such as cd11b and granulocyte colony stimulating factor receptor (GCSFr). Differentiated cells having neutrophil like morphology were observed when treated with 1.0 uM to 7.5 uM ORM which clearly indicates that ORM can induce differentiation in myeloid leukemia cells. At higher doses (5uM to 7.5uM) there is early onset of myeloid differentiation (24 to 48h) with reduced no. of cells which is likely due to apoptotic effects of ORM at higher does. In contrary, lower doses (1uM) induce differentiation after longer duration (6-15days) with quite reduced apoptotic effect.

AN ANTI-LEUKEMIC AGENT USEFUL FOR INDUCING DIFFERENTIATION IN MYELOID LEUKEMIA CELLS

The following specification particularly describes the invention and the manner in which it is to be performed:

Field of Invention

Present invention relates to an anti-leukemic agent useful for inducing differentiation in myeloid leukemia cells. More particularly the present invention relates to Ormeloxifene (here after abbreviated as ORM) that induces differentiation in myeloid leukemia cells. ORM has been tested and licensed as a birth control pill, as well as in the treatment of dysfunctional uterine bleeding. The present invention provides an insight into new role of ORM in inducing differentiation in myeloid leukemia where block in differentiation is a common feature.

Background of the Invention

Myeloid leukemia is a hematologic malignancy characterized by the block in differentiation and abnormal proliferation of clonal myeloid blast cells. Despite extensive clinical research with numerous combinations of cytotoxic agents the overall prognosis of myeloid leukemia patients remains poor, thus hunt for better effective agents is ongoing (U.Krug,et.al.; Curr Opin Hematol, **2010,**17(2):85-90; W.W.Ma, et.al.; Cancer J Clin, **2009**, 59(2),111-37). Ormeloxifene (3,4-trans-2,2-dimethyl-3-phenyl-4-p-(beta-pyrrolidinoethoxy) phenyl-7-methoxychroman), also known as Centchroman, the chemical structure of which is shown in Figure 1a, is a potent non-steroidal selective estrogen receptor modulator (SERM) used as oral contraceptive for birth control. ORM suppresses the receptors in the reproductive organs like the ovaries, uterus and breasts while it stimulates the estrogen receptors of organs like the bones (A. Mukhopadhyay et. al.; Cancer Lett, **1999**, 144(2),137-43; M.M.Singh, MedResRev, **2001**, 1(4),302-47; V Kumar et.al.; Contraception, **2006,** 74(2), 165-73).

Substantial evidence has been amassed to support the premise that ORM has potential anticancer activity (N.C.Misra et.al.; IntJCancer, **1989,** 43(5), 781-3). So, while it acts as a birth control pill it can prevent breast cancers, uterine cancers and stimulate the formation of new bones (M.M.Singh, Med Res Rev, **2001**,21 (4):302-347). In a published study, Mishra et.al, evaluated the role of ORM in breast cancer patients. Apparently, treatment with ORM was evaluated in 4 male and 75 female patients with advanced breast cancer. The overall response rates including both male and female cases, was 40.5%. Among the female patients, the overall response rate was 38.7%. One of the 4 male patients showed a complete response and 2 showed partial responses. The responses were more marked for bone, pulmonary, soft tissue, skin and lymph-node metastases than for liver metastases (N.C.Misra, et.al.; IntJCancer, **1989, 43**(5), 781-3). Furthermore, ORM can reduce the mutagenic effects of known genotoxic compounds dimethylbenz[*a*]anthracene (DMBA),

cyclophosphamide (CP), mitomycin C (MMC) and ethyl methanesulfonate (EMS) in *Salmonella*. These protective activities of ORM against the known positive mutagens in the *Salmonella* may be due to induction of apoptosis by ORM, which leads to the elimination of cells damaged by these mutagens from the cell population (A.K.Giri, et.al.; Mutagenesis, **1999**,14 (6):613-620). Arrested differentiation and increased cell proliferation due to transformation of immature hematopoietic cells is the hallmark of leukemia. This prolongs the growth factor-independent survival of leukemic progenitors by inhibiting the apoptosis. Therefore, agents that can eliminate transformed cells by induction of apoptosis and differentiation in arrested cells rather than merely slowing down their proliferation may have larger therapeutic potential. The increased understanding of apoptosis pathways has directed attention to components of these pathways as potential targets for therapeutic agents (D.G.Tenen, NatRevCancer, **2003**, 3(2):89-101). Indeed, an increasing number of previously identified therapeutic agents including, retinoids, vitamin D_3 analogues, Benzothipopenes, Chlorogenic acid, Guggulsterone, Shikonin, Boswelic Acid, CDDO, Resveratrol and others were found to enhance apoptosis and induce differentiation in a variety of premalignant or malignant leukemia cell types *in vitro* and in a few animal models *in vivo* (G.Bandyopadhyay et.al.; Blood, **2004**, 104 (8):2514-2522; Z.Estrov et.al.; Blood, **2003**, 102(3):987-995; Y.Jing,et.al.; CancerRes, 2005,65(17) 7847-7855; X.Mao et.al.; CellRes **2008**, 18(8):879-888; L.Xia et.al.; MolCancerTher, **2005**, 4(3):381-388). With this pre-context, in our earlier study we have showed the anticancer activity of ormeloxifene in myeloid leukemia cells. We have shown that ormeloxifene at an IC_{50} of 7.5uM induces apoptosis in HL60, U937 and K562 cells (P.Pal, et.al; Proteomics, **2011**, 11 (8):1517-1529). Our studies clearly demonstrate that ormeloxifene can induce apoptosis in myeloid leukemia cells. Most of the anticancer compounds having potential to induce apoptosis in leukemic cells have been shown to induce differentiation at subapoptotic doses (S. Koschmieder, et. al.; Blood, **2007,** 110 (10):3695-3705). Therefore, here we sought to investigate if ORM has also any differentiation inducing potential in myeloid leukemia cells and thus in the present invention we have investigated the new role of non-steroidal anti contraceptive "Ormeloxifene" in myeloid leukemia.

Earlier P Pal et al reported that this antileukemic agent ORM induces apoptosis (P.Pal et al.; Proteomics, **2011**, 11 (8):1517-1529) at a concentration of 7.5uM. However results of present invention reveals that ORM at a concentration of 7.5 uM also induces differentiation when used for a shorter time period. Moreover ORM at a concentration of 1.0 uM also induces differentiation when treated for longer time period in myeloid leukemia cells. Therefore ORM is advantageous over other antileukemic agents which either induce apoptosis or differentiation alone. This antileukemic agent induces myeloid differentiation which is marked by induction of myeloid differentiation markers.

Objects of the invention:

Therefore one of the objects of present invention is to provide an anti-leukemic agent that can induce differentiation in myeloid leukemia cells.

Another object of the present invention is to provide new use of a non-steroidal anti contraceptive Ormeloxifene as an anti leukemic agent.

Summary of the invention:

Accordingly the present invention provides an anti-leukemic agent useful for inducing differentiation in leukemia cell, said anti-leukemic agent is a non-steroidal anti contraceptive drug Ormeloxifene having the structural formula as shown in Figure 1a.

In an embodiment of present invention the anti-leukemic agent Ormeloxifene useful for induction of differentiation in leukemia cell is dose dependent, preferably at a dose ranging 1uM - 7.5uM.

In yet another embodiment of present invention the said anti-leukemic non steroidal drug ormeloxifene induces granulocytic differentiation in K562, a leukemia cell line.

In another embodiment of present invention the non-steroidal anti contraceptive drug Ormeloxifene promotes myeloid differentiation in HL60 and U937, a promyelocyte and myelomonocyte leukemia cell line.

Accordingly, the present invention provides new use of clinically validated drug Ormeloxifene as an anti-leukemic agent *in vitro*, useful for the management or prevention or treatment or cure of human leukemia.

One embodiment of the present invention provides the compound Ormeloxifene as useful in inducing differentiation in wide range of myeloid leukemias including acute promyelocytic leukemia, acute myeloid leukemia and chronic myeloid leukemia where block in differentiation is common feature.

Further embodiment of the present invention provides Ormeloxifene induced differentiation that marked by increase in differentiation marker proteins like C/EBPα and surface proteins such as cd11b ar granulocyte colony stimulating factor receptor (GCSFr).

Brief description of drawings

Fig 1: ORM induces cell toxicity in myeloid leukemia cells: (a) Chemical structure of ormeloxifene. **(b)** Cell viability as determined by MTT colorimetric assay, shows % viable cells after

myeloid leukemia cells were treated with increasing doses of ormeloxifene. Assay was performed on 3 replicates for each treatment and repeated twice. 50% growth inhibition was observed at around 7.5uM.

Fig 2: ORM induces myeloid differentiation in K562 cells: Flow cytometry analysis shows that early myeloid differentiation marker cd11b is increased in ATRA treated HL60 (Upper panel; served as control for differentiation) and ORM treated K562 cells (1uM ORM middle panel; 7.5uM ORM lower panel) in the indicated time point.

Fig 3: ORM induces differentiation like morphology in K562 cells: (a) Giemsa staining of K562 cells treated with 1uM ORM for 12 days and 5uM for 72hrs shows neutrophil like morphological changes. **(b)** NBT staining of K562 cells after treatment with 7.5uM ORM for 24h and 48h, 5uM ORM for 72h and 1uM ORM for 6 days shows purple blue colouration as compared to control K562 which is indicator of NBT reduction by neutrophils.

Fig 4: ORM induced myeloid differentiation is marked by up regulation of differentiation related markers in K562 cells: Real time PCR (RT-PCR) showing significant increase in mRNA expression of **(a)** cd11b **(b)** C/EBP epsilon **(c)** C/EBP alpha **(d, e)** GCSFr **(f, g)** Reverse transcriptase-PCR shows the marked increase in the level of GCSFr.

Fig 5: ORM at a dose of 1uM induces ROS generation: A property of activated neutrophils: Flow cytometry analysis was performed for the ROS generation in K562 cells after treatment with 1uM ORM for 24h and 48h. Cells were labeled with DCF-DA dye and fluorescence was measured. A shift in the peak was observed in the K562 cells treated with 1uM ORM after 48h.

Fig 6: ORM induces myeloid differentiation in primary cells isolated from CML patients PBMCs were isolated from patient samples and were analyzed by FACS for cd11b positive cells. There was increase in the expression of **(a)** cd11b and **(b)** cd114 after treatment of cells with 1uM ORM for 24 h and 48h **(c)** Graphically shows percentage of cd11b and cd114 positive cells in FACS analysis.

Fig 7: ORM at 1uM dose induces differentiation like morphology both in HL60 and U937 cells: (a) HL60 and **(b)** U937 cells were treated with 1uM ORM for 12 and 15 days and there was change in the morphology of cells by decrease in the nuclear and cytoplasmic ratio and formation of multilobed nuclei which is typical for neutrophilic differentiation.

Detailed description of the invention

The compounds, methods, compositions and activity testing illustrated in details as follows:

1. Cell culture and plasmids: HL60, U937 and K652 cells were cultured in RPMI1640 supplemented with 10% FBS and 1% antimycotic and antibiotics. Cells were cultured in 5% CO_2 humified incubator at 37°C.

2. MTT assay: Post 6h synchronization, $1x10^4$ cells per well were incubated at 37°C in 96-well plastic plates with test drugs containing 10% FBS in an environment of 5% humified CO_2. After 48 hrs, cell viability was assessed by the ability of metabolically active cells to reduce tetrazolium salt (XTT) to coloured formazan compounds. The absorbance of the samples was measured with a specific enzyme-linked immunosorbent assay (ELISA) reader at 560 nm.

3. Giemsa staining: Giemsa stain is used to differentiate nuclear and cytoplasmic morphology of blood cells. After induction with 1uM ORM for 12 days cells were cytospun on slides at 800rpm for 5 min and were air dried. Cells were stained with Giemsa stain (Sigma) as per manufacturer's protocol. Cells were visualized microscopically for the morphological changes.

4. NBT assay: The NBT Assay relies on the accumulation of blue black formazan precipitate. The membrane permeable, water soluble, yellow NBT is reduced to blue black formazan by O^-_2 which is generated by activated neutrophils/ phagocytes, typically by PMA. PMA activates NADPH oxidase by enhancing protein kinase C (PKC) and thus stimulates production of ROS (reactive oxygen species). After induction with 7.5uM ORM for 24h and 48hr and with 1uM ORM for 6 days cells were incubated in NBT solution for 15min. at 37°C. Cells were washed with PBS and were resuspended in 500ul PBS and cytospun on slides and stained with safranin O for 1min. Number of cells showing blue-purple colouration were counted under microscope.

5. Quantitative PCR (Real Time) and semi quantitative PCR Analysis: After induction of cells with ORM for indicated time points cells were harvested and RNA was isolated using Trizol reagent. Trizol was added to $1x10^6$ cells for 5 min at room temp. Lysed cells were collected in micro centrifuge tubes and shaken vigorously for 15 sec, and incubated for 3 min at RT. 200 µl of chloroform was added to each sample and incubated yet again for 5 min at RT. Cells were centrifuged at 15,000 rpm for 15 min at 4°C. Supernatant was collected in fresh tube; 1 ml isopropanol was added and incubated for 10 min at RT. Pellet was washed once with 70% ethanol and RNA concentration was quantified. Further, RNA was retro-transcribed into cDNA and subsequently used for quantitative PCR analysis on Roche Light Cycler 480 using SYBR green master mix from Applied Biosystems. Statistical analysis was performed using ΔΔCT method. Reverse transcriptase PCR was done to check the mRNA level expression of GCSFr qualitatively. RT-PCR analysis was performed using standardized PCR protocol on BioRad C1000 Thermal Cycler.

6. PBMC separation from patient sample: 10ml peripheral blood was collected by venipuncture heparin-containing 20ml vials. Peripheral blood mononuclear cells were isolated using density gradient centrifugation with Ficoll-Paque (1.077 g/ml).Peripheral blood was mixed in 1:1 v/v of MACS buffer and was fractionated through Ficoll-Paque. Mononuclear cells were collected from the interface, washed twice in MACS buffer and resuspended in RPMI 1640 at 37°C in the humidified atmosphere of 5% CO_2.

7. FACS analysis: Cells were treated with 1uM ORM for 24h and 48h.Then they were washed with 1X PBS and resuspended in antibody solution along with their respective IgG isotype control for 15-20 min as per manufacturer's protocol. Cells were washed once with PBS and were resuspended in 500ul of PBS. After this flow cytometry was done for PI labeled cells for cd11b and cd114 differentiation markers (BD Biosciences).

Following examples are provided from the results obtained from the experiments as provided above. These should, however, not be construed to limit the scope of invention.

Example - 1

ORM induces growth inhibition in myeloid leukemia cells:

To calculate 50% growth inhibitory concentration (IC_{50}) of ormeloxifene, various myeloid leukemia cells (U937, HL60, K562) and HEK293T as control were assayed with different doses of ormeloxifene for cell viability in MTT Assay. ORM showed IC_{50} of ~7.0uM in leukemic cells as compared to 25uM for 293T (Fig. 1b). Various apoptosis assays were performed in myeloid leukemia cells upon treatment with ormeloxifene that induces G0-G1 phase growth arrest and caspase mediated apoptosis in myeloid leukemia via ERK activation.

Example - 2

ORM induces differentiation in myeloid leukemia cells:

K562 cells were treated with 1µM (Subapoptotic dose) and 7.5µM ORM (Apoptotic dose) for 24 h and 48hrs. Post 24h and 48h treatment, cells were analyzed in FACS-flow cytometer for the presence of myeloid differentiation marker cd11b (Fig. 2). In parallel, HL60 cells were also treated with 1uM All-Trans-Retinoic Acid (ATRA) for 72hrs which served as control for induction of differentiation. Notably, increased percentage of cells expressing CD11b markers were observed after 24 and 48h in cells treated with 1.0uM ORM. Reduced number of cd11b expressing cells upon induction of 7.5uM ORM may be due to prominent apoptosis imparted by ORM at this dose. Isotype IgG-PE antibody served as negative control.

To further corroborate the differentiation inducing potential of ORM, K562 cells were again treated with 1.0uM ORM and vehicle for 12days followed by cytospin and staining with Giemsa for assessment of morphological changes. As shown in Fig. 3a, differentiated cells having neutrophil like morphology were observed which clearly indicates that ORM can induce differentiation in myeloid

leukemia cells. It is noteworthy to mention here that at higher doses (5uM to 7.5uM) there is early onset of myeloid differentiation (72h for 5uM and 24,48h for 7.5uM) with reduced no. of cells which is likely due to apoptotic effects of ORM at higher dose. In contrary, at lower doses (1uM) differentiation is observed after longer duration (6-15days) with quite reduced apoptotic effect.

Example -3

Confirmation of differentiation with biochemical assay:

In order to further confirm the ORM induced differentiation in myeloid leukemia cells, Nitro Blue Tetrazolium (NBT) reduction assay is carried out which is a biochemical assay wherein activated granulocytes can reduce NBT to insoluble purple blue colour precipitates. Further, because ORM induces apoptosis at 7.5uM in K562 cells; we treated K562 cells with 7.5uM for 24 h and 48hrs and 1uM doses for longer duration, 6 days. Cells were subjected for NBT reduction analysis. As shown in the Fig. 3b, dramatic increase in NBT reduction marked by purple blue coloration in the ORM treated cells was observed. This further confirmed differentiation inducing potential of ORM.

Furthermore, ORM induces granulocytic differentiation in K562 cells, it should lead to terminal differentiation of these cells to activated neutrophils. To substantiate further the induction of granulocytic differentiation and neutrophil formation, we measured the ROS generation, which is a property of activated neutrophils by FACS flow cytometer. Significant upregulation in ROS generation upon 1uM ORM induction in K562 cells was observed (Fig. 5) which suggests ORM indeed induces granulocytic differentiation in these cells.

Example - 4.

ORM induced differentiation in myeloid leukemia cells correlates with enhanced expression of differentiation-regulated genes.

ORM induced myeloid differentiation was further demonstrated by assessing the changes in molecular markers of myeloid differentiation. Quantitative real time PCR from 1uM ORM induced K562 cells (for 24 and 48h) showed increased mRNA expression of cd11b (general myeloid differentiation marker (S. Koschmieder et.al.; Blood, **2007,** 110(10):3695-3705), C/EBPalpha, C/EBP epsilon and GCSFr (markers of granulocytic differentiation; Fig. 4a,b,c,d). In addition, quantitative and semi quantitative PCR of 7.5uM ORM treated K562 cells after 24h and 48h also showed modest upregulation of GCSFr (Fig. 4e, f) suggesting ORM does induces granulocytic differentiation in K562 cells. Expression of GSCFr expression after six days treatment with 1uM ORM further demonstrated induction of differentiation in these cells (Fig. 4g).

Example- 5

ORM induces myeloid differentiation in Primary cells isolated from CML patients

Significant advances made in cancer therapy during the last decade as our understanding of molecular biology and leukemogenesis evolved, suggests that leukemic cell proliferation, apoptosis and differentiation should be targeted by anti leukemic agents. Although recent studies using differentiation therapies in oncology have been successful for acute promyelocytic leukemia (APL) with the use of all-trans retinoic acid (ATRA) (S.Waxman, Leukemia, **2000**, 14(3):491-496), little is known about exact mechanisms of differentiation. Since ORM profoundly induces granulocytic differentiation in K562 cells, we sought to assess if these in-vitro effects of ORM can be translated to primary cells isolated from chronic myeloid leukemia patients. 10ml of peripheral blood upon prior consent of patients were drawn, mononuclear cells were separated using ficol-hypaq gradient centrifugation and cultured in RPMI supplemented with 10% FBS. 24h post culture, cells were washed and plated at a density of $2x10^5$ cells/ml. Cells were treated with 1uM ORM and were analyzed for expression of cd11b and cd114 surface markers after 24 and 48hr. As shown in Fig. 6a and b, significant upregulation in expression of myeloid and granulocytic differentiation markers were observed.

Taken together, these data show that the effects of ORM in myeloid cells can be translated in primary mononuclear cells isolated from CML patients.

Example - 6

ORM induces differentiation in HL60 and U937 cells

Profound granulocytic differentiation inducing property of ormeloxifene in K562 prompted us to investigate if ORM can also induce such differentiation in other myeloid leukemia cell lines. So we further chose HL60 and U937, a promyelocyte and myelomonocyte leukemia cell line. These cells differentiate to granulocyte lineage upon induction with all trans-retinoic acid (ATRA) and represent a very good model cell line for such differentiation assays. These cells were treated with 1uM ORM for longer duration of 12 and 15 days followed by assessment of granulocytic/neutrophil like morphology. As seen in Fig. 7a,b large number of cells with multilobed nucleus, a feature of differentiated myeloid cells was observed suggesting ORM indeed promotes myeloid differentiation.

Advantages of the invention

The new use of commercially available contraceptive as an antileukemic agent has several advantages; it is well established drug having well documented toxicity and other physiologically relevant pharmacological parameters. Since it is known to induce apoptosis and now we show that it also induces myeloid differentiation at varying doses well within toxicity limits, it offers a very good direct therapeutics either alone or in combination with other antileukemic drugs.

We claim:

1. An anti-leukemic agent useful for inducing differentiation in myeloid leukemia cells, said anti-leukemic agent is a non-steroidal anti contraceptive drug Ormeloxifene having the structural formula as shown in Figure 1a.

2. An anti-leukemic agent as claimed in claim1 useful for induction of differentiation in leukemia cell is dose dependent, preferably at a dose ranging 1uM - 7.5uM.

3. An anti-leukemic agent as claimed in claim1-2 useful for induction of differentiation when treated at a concentration ranging 5.0uM to 7.5uM for a short duration of period ranging 24-48 hours.

4. An anti-leukemic agent as claimed in claim1-3 useful for induction of differentiation when treated at a concentration of 1.0 uM for longer duration ranging from 6-15 days.

5. An anti-leukemic agent as claimed in claim1 and 4 wherein the said anti-leukemic agent induces granulocytic differentiation in K562 leukemia cell line.

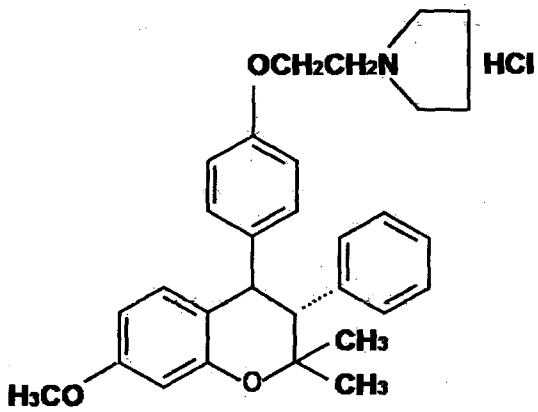
6. An anti leukemic agent as claimed in claim 1 to 5 wherein the said anti-leukemic agent promotes myeloid differentiation in HL60 and U937, a promyelocyte and myelomonocyte leukemia cell line.

7. Use of anti- leukemic agent Ormeloxifene, a clinically validated drug useful for the management or prevention or treatment or cure of human leukemias.

8. Use of anti- leukemic agent Ormeloxifene in inducing differentiation in wide range of myeloid leukemias including acute promyelocytic leukemia, acute myeloid leukemia and chronic myeloid leukemia where block in differentiation is common feature.

9. Use of anti- leukemic agent Ormeloxifene wherein Ormeloxifene induced differentiation is marked by increase in differentiation marker proteins like C/EBPα and surface proteins such as cd11b and granulocyte colony stimulating factor receptor (GCSFr).

Fig. 1a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HCl
CH3
CH3
H3CO
O

b

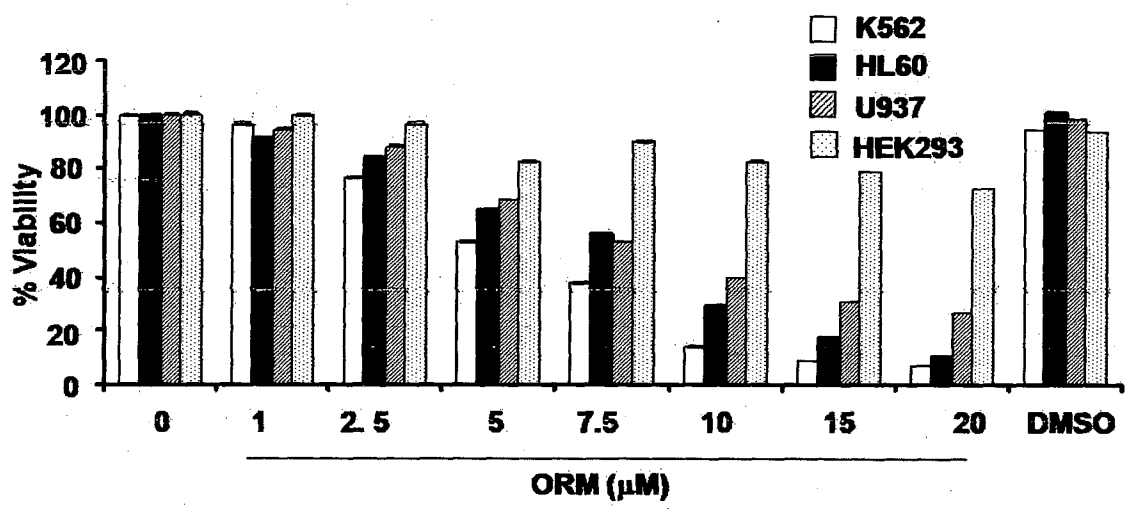
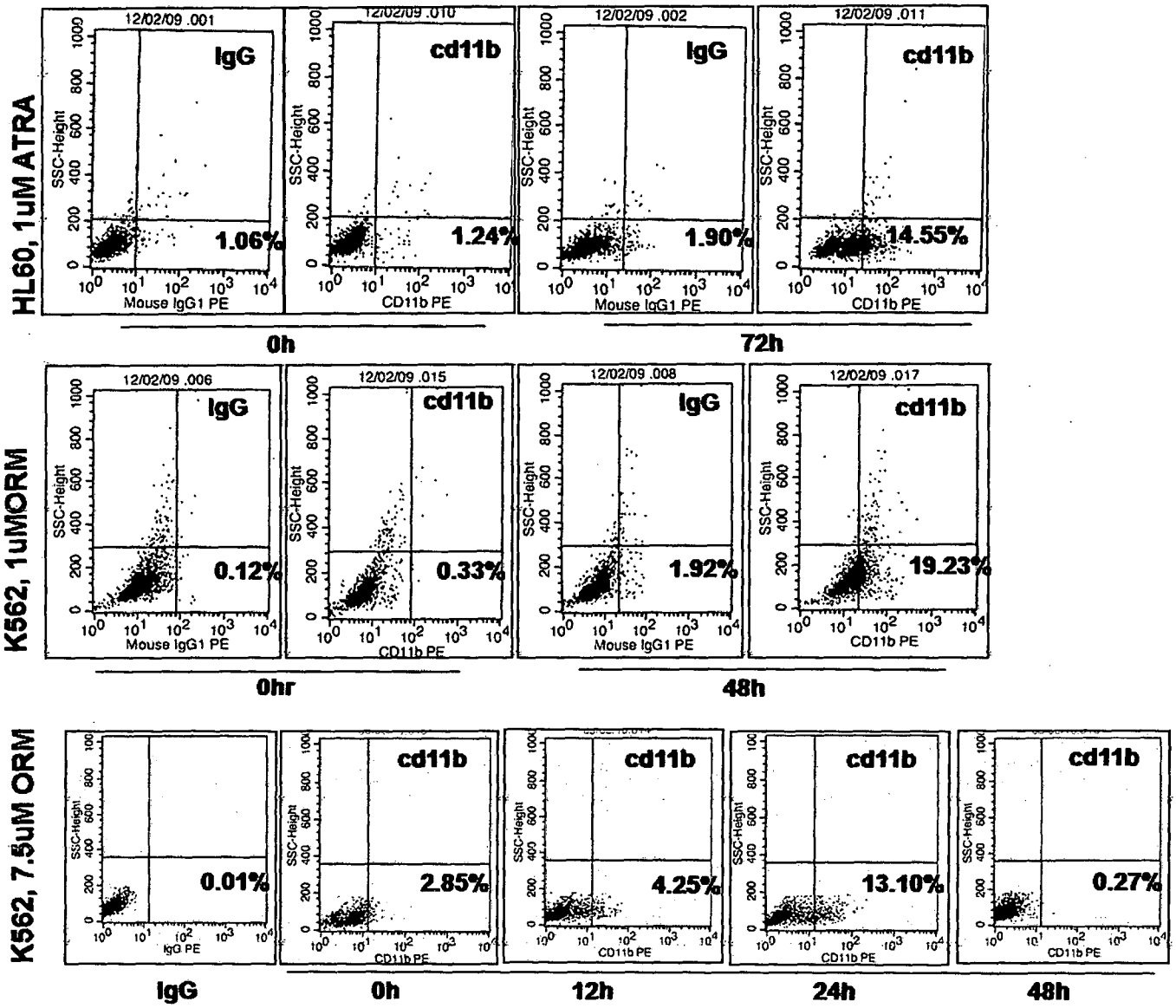
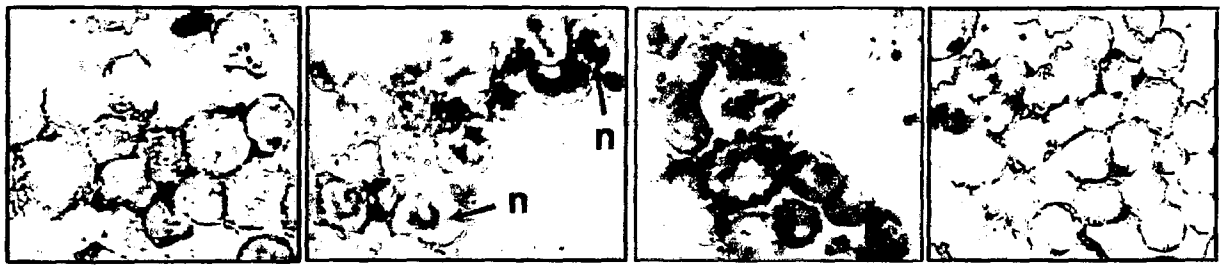

K562
HL60
U937
HEK293
% Viability
120
100
80
60
40
20
0
0
1
2.5
5
7.5
10
15
20
DMSO
ORM (μM)

Fig.2

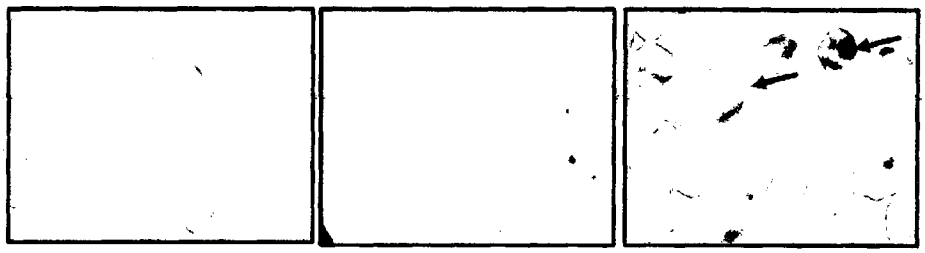

HL60, 1uM ATRA
12/02/09 .001
IgG
1.06%
Mouse IgG1 PE
12/02/09 .010
cd11b
1.24%
CD11b PE
12/02/09 .002
IgG
1.90%
Mouse IgG1 PE
12/02/09 .011
cd11b
14.55%
CD11b PE
0h
72h
K562, 1uMORM
12/02/09 .006
IgG
0.12%
Mouse IgG1 PE
12/02/09 .015
cd11b
0.33%
CD11b PE
12/02/09 .008
IgG
1.92%
Mouse IgG1 PE
12/02/09 .017
cd11b
19.23%
CD11b PE
0hr
48h
K562, 7.5uM ORM
0.01%
IgG PE
cd11b
2.85%
CD11b PE
cd11b
4.25%
CD11b PE
cd11b
13.10%
CD11b PE
cd11b
0.27%
CD11b PE
IgG
0h
12h
24h
48h
SSC-Height

a: Gimesa Staining

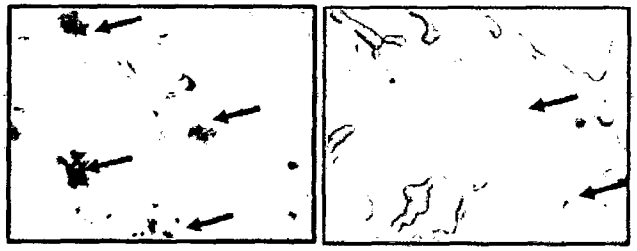


K562 unin 12 days | 1uM ORM 12days | 5uM ORM 72h | DMSO 12 days

b: NBT staining

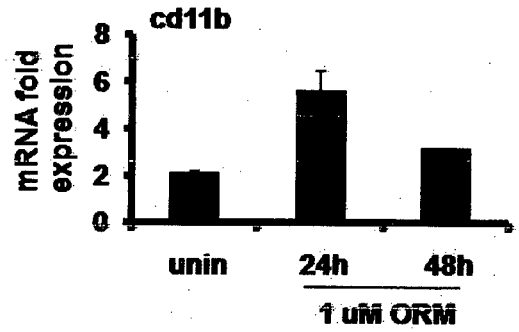


K562 uninduced | 7.5uM ORM 24h | 7.5uM ORM 48h

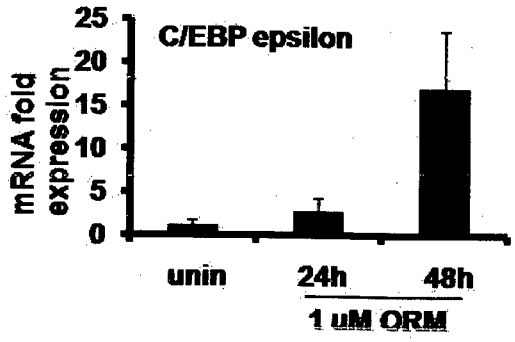


1uM ORM 6 days | 5uM ORM 72h

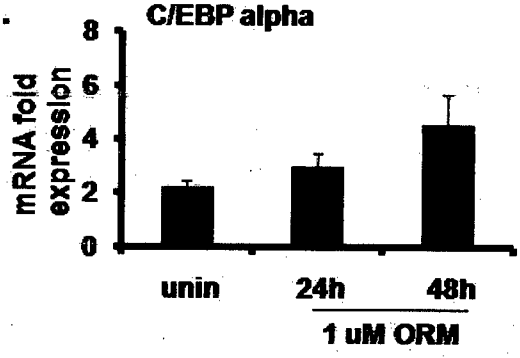
Fig. 4a


cd11b
mRNA fold expression
8
6
4
2
0
unin
24h
48h
1 uM ORM

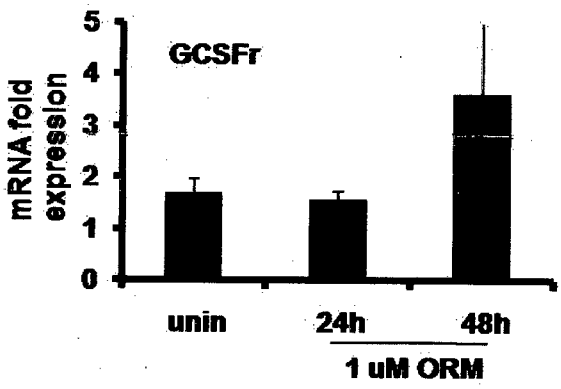
b.


C/EBP epsilon
mRNA fold expression
25
20
15
10
5
0
unin
24h
48h
1 uM ORM

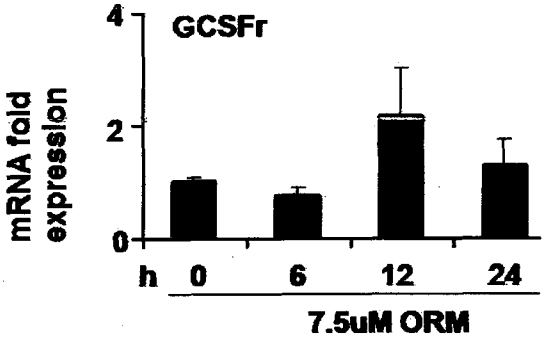
c.


C/EBP alpha
mRNA fold expression
8
6
4
2
0
unin
24h
48h
1 uM ORM

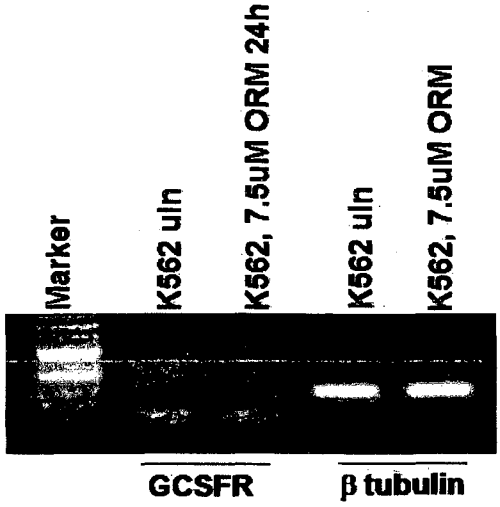
d.


GCSFr
mRNA fold expression
5
4
3
2
1
0
unin
24h
48h
1 uM ORM

4 e.


GCSFr
mRNA fold expression
4
2
0
h 0 6 12 24
7.5uM ORM

f.


Marker
K562 uln
K562, 7.5uM ORM 24h
K562 uln
K562, 7.5uM ORM
GCSFR
β tubulin

g.

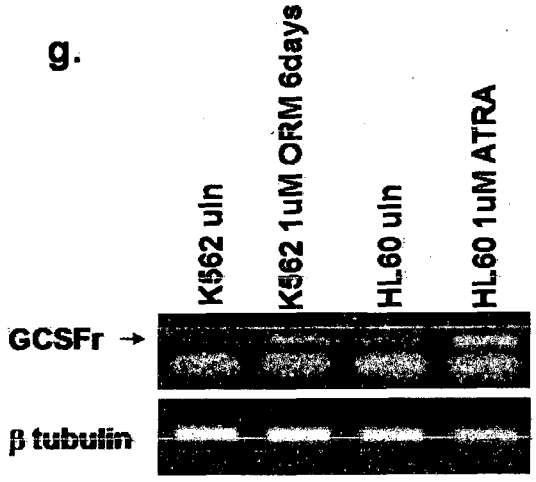

K562 uln
K562 1uM ORM 6days
HL60 uln
HL60 1uM ATRA
GCSFr
β tubulin

Fig. 5

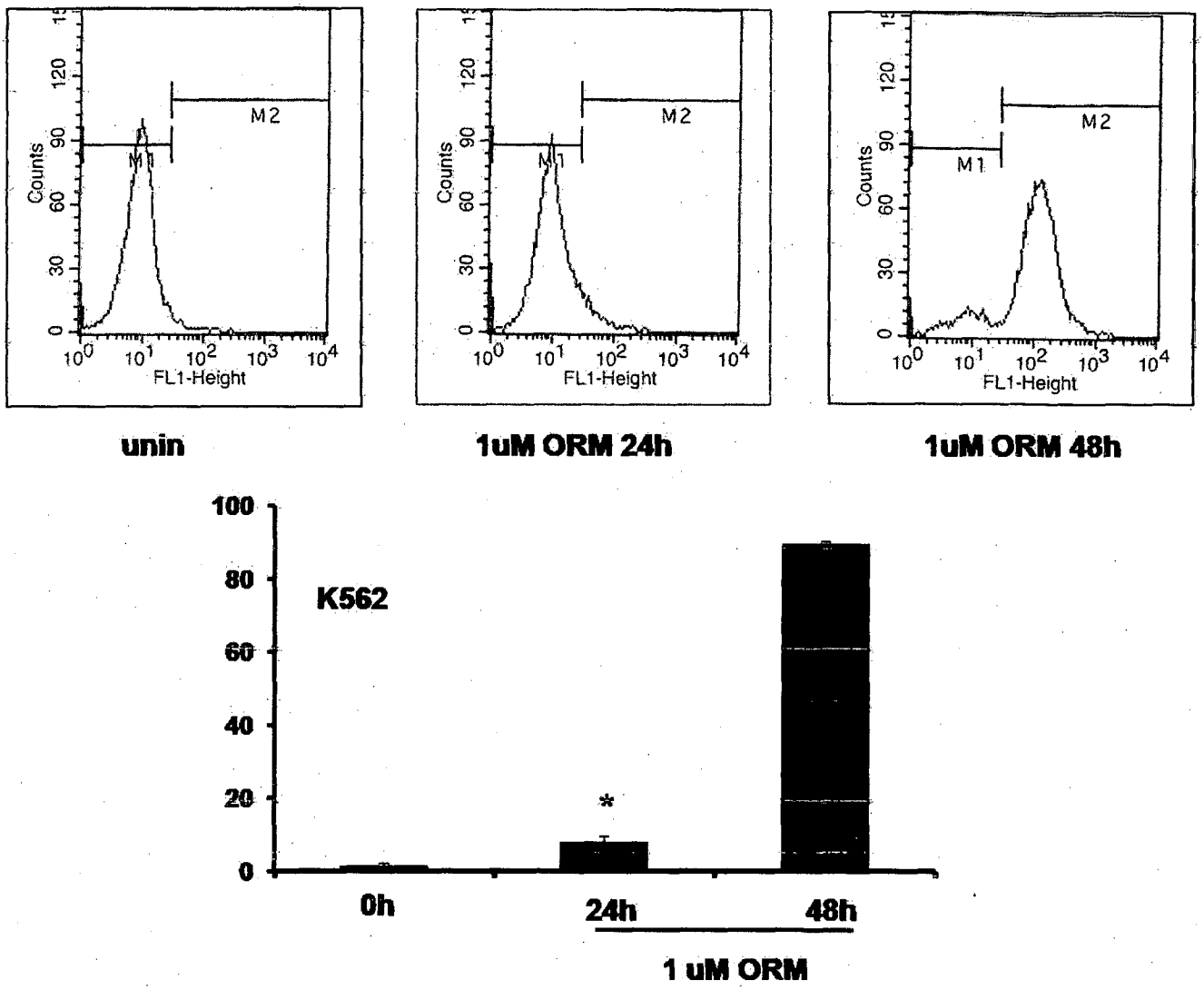
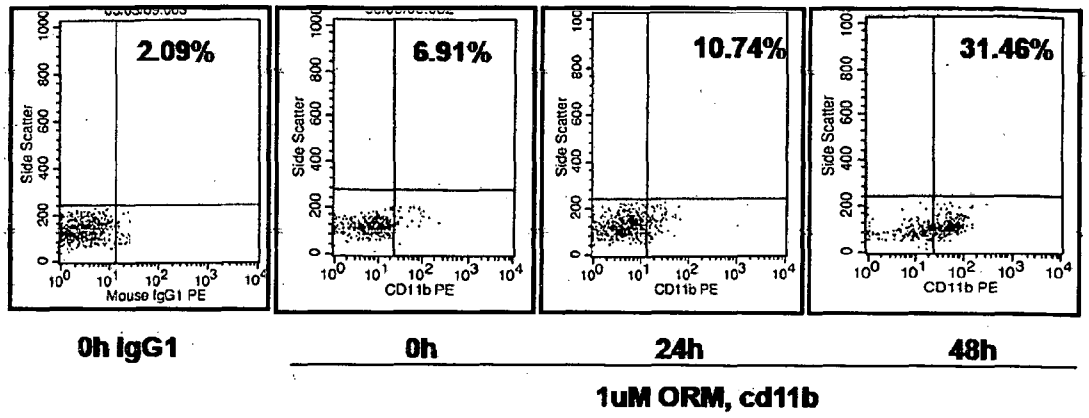
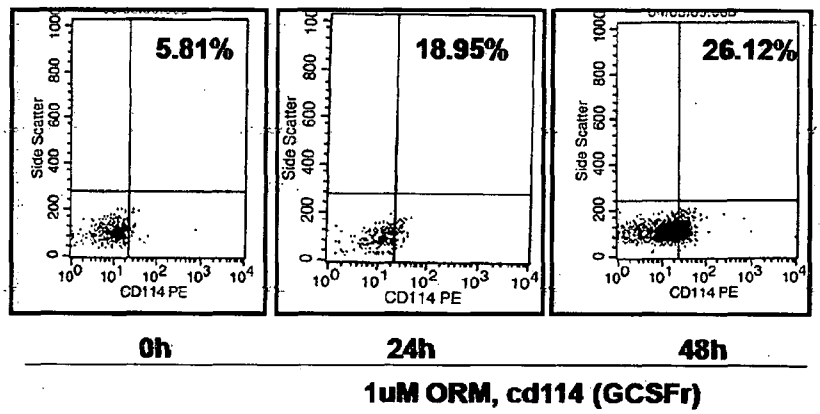

M1
M2
Counts
FL1-Height
unin
1uM ORM 24h
1uM ORM 48h
K562
100
80
60
40
20
0
*
0h
24h
48h
1 uM ORM

Fig. 6a


2.09%
6.91%
10.74%
31.46%
Side Scatter
Mouse IgG1 PE
CD11b PE
0h IgG1
0h
24h
48h
1uM ORM, cd11b

b.


5.81%
18.95%
26.12%
Side Scatter
CD114 PE
0h
24h
48h
1uM ORM, cd114 (GCSFr)

c.

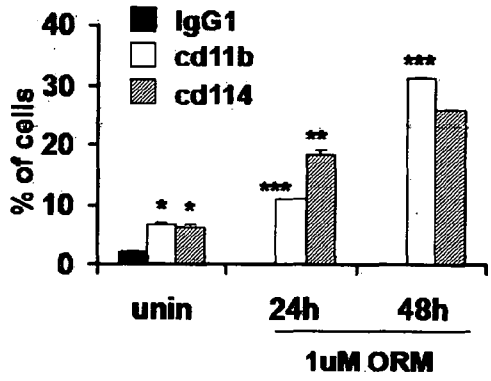

IgG1
cd11b
cd114
% of cells
40
30
20
10
0
unin
24h
48h
1uM ORM

Fig. 7a

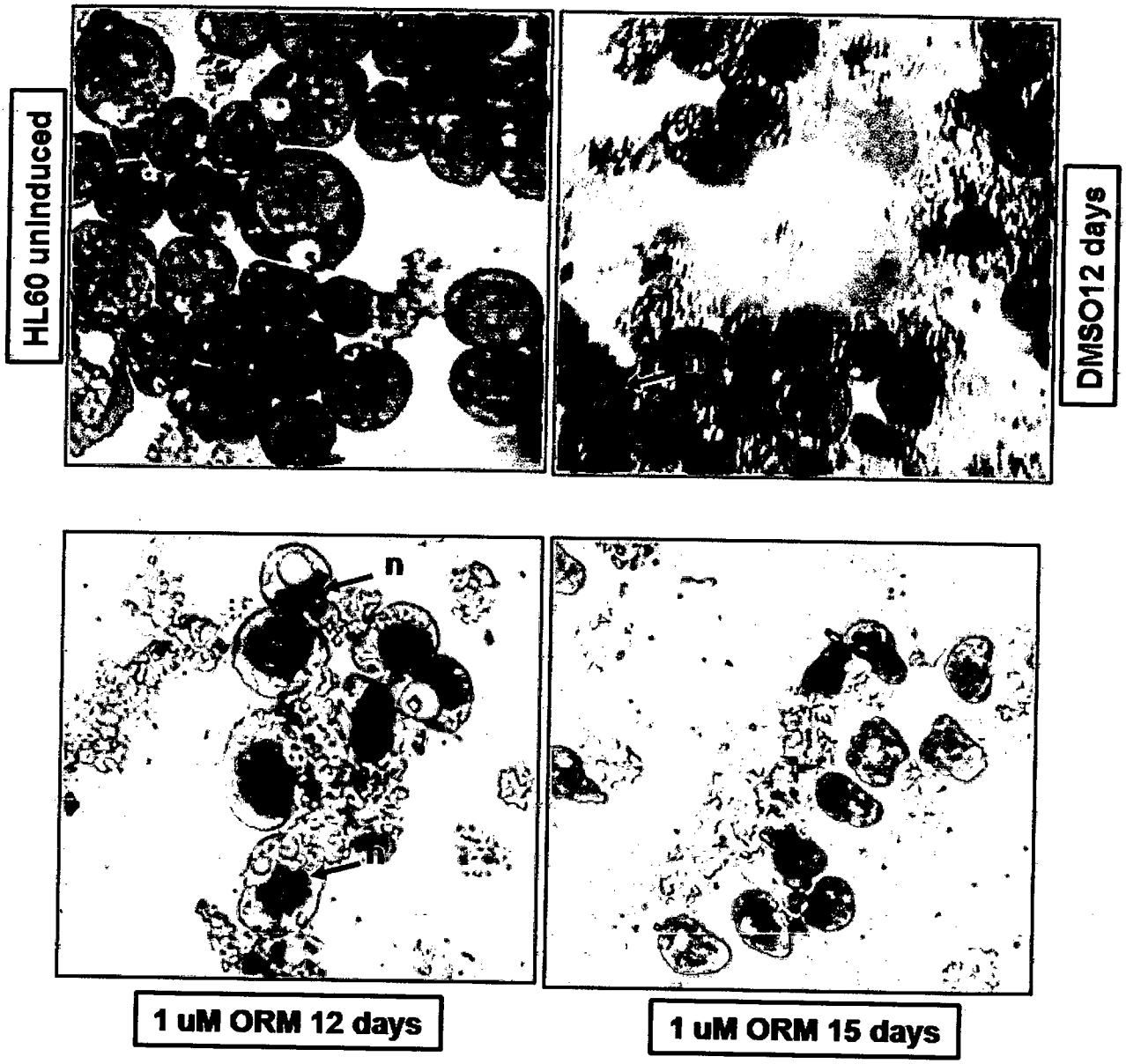
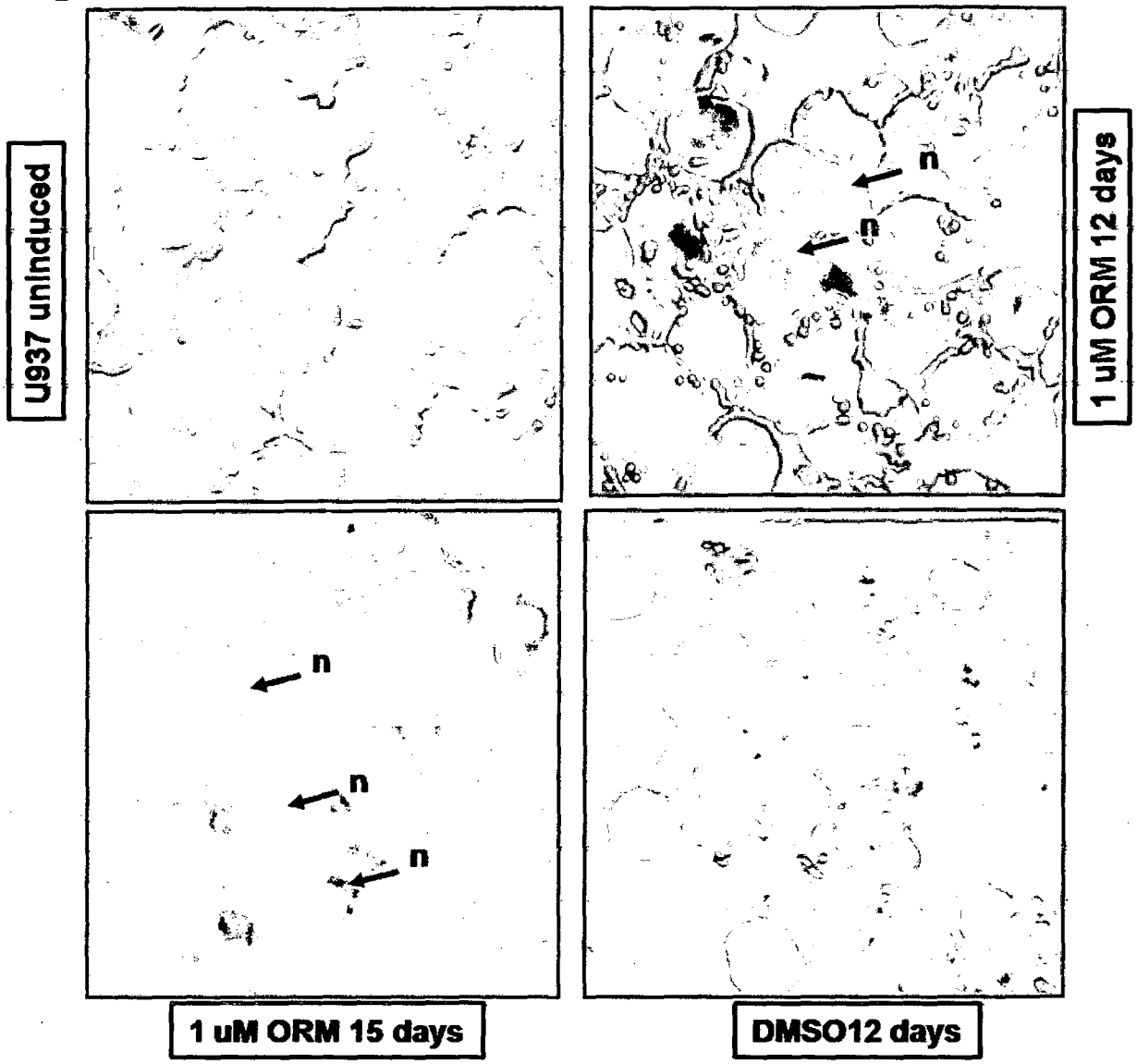


Fig. 7b


U937 uninduced
1 uM ORM 12 days
n
n
n
n
n
1 uM ORM 15 days
DMSO12 days

INTERNATIONAL SEARCH REPORT

International application No
PCT/IN2014/000131

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61K31/4025 A61P35/02
ADD.

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)
A61K

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)
EPO-Internal, BIOSIS, CHEM ABS Data, EMBASE, PASCAL, SCISEARCH, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	POOJA PAL ET AL: "2-D gel electrophoresis-based proteomic analysis reveals that ormeloxifen induces G0-G1 growth arrest and ERK-mediated apoptosis in chronic myeloid leukemia cells K562", PROTEOMICS, vol. 11, no. 8, 25 April 2011 (2011-04-25) , pages 1517-1529, XP055129912, ISSN: 1615-9853, DOI: 10.1002/pmic.201000720 cited in the application	1-7
A	the whole document	8,9

-/--

[X] Further documents are listed in the continuation of Box C.

[ ] See patent family annex.

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"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
21 July 2014	29/07/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Albrecht, Silke

2

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IN2014/000131

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	S WAXMAN: "Differentiation therapy in acute myelogenous leukemia (non-APL)", LEUKEMIA, vol. 14, no. 3, March 2000 (2000-03), pages 491-496, XP055130547, DOI: 10.1038/sj.leu.2401714 cited in the application the whole document -----	1-9