

# 白芍网络药理学

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# Contents

<b>1 摘要</b>	<b>1</b>
1.1 需求和结果 . . . . .	1
<b>2 前言</b>	<b>1</b>
<b>3 材料和方法</b>	<b>1</b>
3.1 材料 . . . . .	1
3.2 方法 . . . . .	1
<b>4 分析结果</b>	<b>2</b>
<b>5 结论</b>	<b>2</b>
<b>6 附：分析流程</b>	<b>2</b>
6.1 TCMSP 白芍成分获取 . . . . .	2
6.2 白芍总苷 (Total glucosides of paeony, TGP) 成分 . . . . .	2
6.2.1 白芍总苷 (Total glucosides of paeony, TGP) 成分和筛选 . . . . .	2
6.2.2 白芍总苷 (Total glucosides of paeony, TGP) 成分的靶点预测 . . . . .	5
6.3 白芍总苷 (Total glucosides of paeony, TGP) 的网络药理学分析 . . . . .	6
6.3.1 白芍总苷 (Total glucosides of paeony, TGP) 成分-靶点 . . . . .	6
6.3.2 白芍总苷 (Total glucosides of paeony, TGP) 和过敏性鼻炎 (allergic rhinitis, AR) 靶基因的交集 . . . . .	7
6.3.3 芍药苷 (Paeoniflorin, P) 和过敏性鼻炎 (allergic rhinitis, AR) 靶基因的交集 . . . . .	8
6.4 富集分析 . . . . .	9
6.4.1 白芍总苷 (Total glucosides of paeony, TGP) 与 AR 交集基因的富集分析 . . . . .	9
6.4.2 芍药苷 (Paeoniflorin, P) 与 AR 交集基因的富集分析 . . . . .	10
6.5 分子对接 . . . . .	11
6.5.1 芍药苷 (Paeoniflorin, P) . . . . .	11
<b>Reference</b>	<b>13</b>

## List of Figures

1 Filterd TGP . . . . .	5
2 SwissTargetPrediction results . . . . .	6
3 Network pharmacology visualization . . . . .	7
4 Baishao TGP targets intersect with AR related targets . . . . .	7
5 Targets of compounds and related disease . . . . .	8
6 Paeoniflorin targets intersect with AR related targets . . . . .	9
7 Network pharmacology visualization of Paeoniflorin . . . . .	9
8 TGP Interect genes KEGG enrichment . . . . .	10

9	TGP Interest genes GO enrichment . . . . .	10
10	Pae Interest genes KEGG enrichment . . . . .	11
11	Pae Interest genes GO enrichment . . . . .	11
12	Overall combining Affinity . . . . .	12
13	Paeoniflorin combine USP5 . . . . .	12
14	Paeoniflorin combine SOX18 . . . . .	13

## List of Tables

1	Baishao Compounds and targets . . . . .	2
2	TCMSP Baishao the found TGP . . . . .	4

# 1 摘要

## 1.1 需求和结果

- 白芍总苷 Total glucosides of paeony 中主要化学成分 10-20 个 (TCMSP 筛选下口服利用度等) 及各个化学成分对应的作用靶点 (gene 与 AR 过敏性鼻炎相关), 最终形成 drug-chemical-target gene 靶点图
- 将获得的靶点进行 GO, KEGG 富集分析, 目标靶点为 USP5, 关联成分为芍药苷 Paeoniflorin
- 将芍药苷 pae 单独拎出, 形成 pae-targets-pathway 网络, 此处形成的 target genes 的 GO、KEGG 富集图也需要, 备注 USP5 参与哪些部分 (功能、通路)
- 分子对接模拟芍药苷与 USP5 互作
- 转至第 2 步目标靶点为 SOX18, 关联成分为芍药苷 Paeoniflorin
- 第 3 步中备注 SOX18 参与哪些部分 (功能、通路)
- 分子对接模拟芍药苷与 SOX18 互作

注: USP5 和 SOX18 不参与功能、通路。其它分析结果见 6

# 2 前言

# 3 材料和方法

## 3.1 材料

## 3.2 方法

Mainly used method:

- R package `ClusterProfiler` used for gene enrichment analysis<sup>1</sup>.
- The API of UniProtKB ([https://www.uniprot.org/help/api\\_queries](https://www.uniprot.org/help/api_queries)) used for mapping of names or IDs of proteins.
- R package `PubChemR` used for querying compounds information.
- Web tool of `SwissTargetPrediction` used for drug-targets prediction<sup>2</sup>.
- Website TCMSP <https://tcmsp-e.com/tcmsp.php> used for data source<sup>3</sup>.
- `AutoDock vina` used for molecular docking<sup>4</sup>.
- R version 4.3.2 (2023-10-31); Other R packages (eg., `dplyr` and `ggplot2`) used for statistic analysis or data visualization.

## 4 分析结果

## 5 结论

## 6 附：分析流程

### 6.1 TCMSP 白芍成分获取

Table 1 (下方表格) 为表格 Baishao Compounds and targets 概览。

(对应文件为 Figure+Table/Baishao-Compounds-and-targets.xlsx)

注：表格共有 990 行 3 列，以下预览的表格可能省略部分数据；表格含有 39 个唯一 ‘Mol ID’。

Table 1: Baishao Compounds and targets

Mol ID	Molecule Name	Target name
MOL001246	(1R)-()-Nopinone	Gamma-aminobutyric-acid rec...
MOL001246	(1R)-()-Nopinone	Cytochrome P450-cam
MOL001246	(1R)-()-Nopinone	Lysozyme
MOL001246	(1R)-()-Nopinone	Alcohol dehydrogenase 1C
MOL001246	(1R)-()-Nopinone	Nicotinate-nucleotide-dime...
MOL001393	myristic acid	Prostaglandin G/H synthase 1
MOL001393	myristic acid	Prostaglandin G/H synthase 2
MOL001393	myristic acid	Cholinesterase
MOL001393	myristic acid	Phospholipase A2
MOL001393	myristic acid	Rhinovirus coat protein
MOL001393	myristic acid	Ig gamma-1 chain C region
MOL001393	myristic acid	Ferrichrome-iron receptor
MOL001393	myristic acid	3-oxoacyl-[acyl-carrier-pro...
MOL001393	myristic acid	Nuclear receptor coactivator 2
MOL001393	myristic acid	Nuclear receptor coactivator 1
...	...	...

### 6.2 白芍总苷 (Total glucosides of paeony, TGP) 成分

#### 6.2.1 白芍总苷 (Total glucosides of paeony, TGP) 成分和筛选

根据提供的文献，搜集其中的白芍总苷 (Total glucosides of paeony, TGP)<sup>5</sup>。

**TGP :**

442534, 51346141, 21631105, 21631106, 138113866, 14605198, 50163461, 102000323, 494717, 138108175, 124079396, 101382399, 102516499, 71452334, 137705343

以 PubChemR 获取这些化合物的同义名:

**442534 :**

Paeniflorin, 23180-57-6, Peoniflorin, Paeonia moutan, NSC 178886, UNII-21AIQ4EV64, 21AIQ4EV64, CCRIS 6494, EINECS 245-476-2, PAEONIFLORIN (USP-RS), PAEONIFLORIN [USP-RS], NSC-178886, ((2S,2aR,2a1S,3aR,4R,5aR)-4-Hydroxy-2-methyl-2a-(((2S,3R,4S,5S,6R)-3,4,5-trihydroxy-6-(hydroxymethyl)tetrahydro-2...

**51346141 :**

Albiflorin, 39011-90-0, SCHEMBL24008597, AC-34702

**21631105 :**

Oxypaeoniflorin, Oxypaeoniflora, 39011-91-1, UNII-3A7O4NBD5S, 3A7O4NBD5S, OXYPEONIFLORIN, NSC 258310, NSC-258310, J17.727J, beta-D-GLUCOPYRANOSIDE, (1AR,2S,3AR,5R,5AR,5BS)-TETRAHYDRO-5-HYDROXY-5B-(((4-HYDROXYBENZOYL)OXY)METHYL)-2-METHYL-2,5-METHANO-1H-3,4-DIOXACYCLOBUTA(CD)PENTALEN-1A(2H)-YL, bet...

**21631106 :**

Benzoylpaeniflorin, 38642-49-8, ChEMBL4861111, CHEBI:69583, HMS3886L18, MFCD00869479, s9149, AKOS037645102, CCG-270143, AC-34005, AS-57134, Q27137925

**138113866 :**

A866179, -D-Glucopyranoside,tetrahydro-5-hydroxy-5b-[[[(4-hydroxybenzoyl)oxy]methyl]-2-methyl-2,5-methano-1H-3,4-dioxacyclobuta[cd]pentalen-1a(2H)-yl,6-benzoate,[1aR-(1aa,2b,3aa,5a,5aa,5ba)]-

**(Others) :**

...

根据同义名, 在 Tab. 1 中搜索这些化合物, 得到:

Table 2 (下方表格) 为表格 TCMSP Baishao the found TGP 概览。

(对应文件为 **Figure+Table/TCMSP-Baishao-the-found-TGP.xlsx**)

注：表格共有 85 行 15 列，以下预览的表格可能省略部分数据；表格含有 1 个唯一 ‘Herb\_pinyin\_name’。

Table 2: TCMSP Baishao the found TGP

Herb_p...	Mol ID	Molecu.....3	Molecu.....4	MW	AlogP	Hdon	Hacc	OB (%)	Caco-2
Baishao	MOL000106	PYG	https:...	126.12	1.03	3	3	22.98	0.69
Baishao	MOL001218	Pisol	https:...	186.38	4.62	1	1	18.5	1.23
Baishao	MOL001246	(1R)-(...	https:...	138.23	1.52	0	1	57.86	1.23
Baishao	MOL001393	myrist...	https:...	228.42	5.46	1	2	21.18	1.07
Baishao	MOL001396	PENTAD...	https:...	242.45	5.91	1	2	20.18	1.08
Baishao	MOL001402	Octaco...	https:...	394.86	13.15	0	0	8.15	1.91
Baishao	MOL001644	Dodecanal	https:...	184.36	4.59	0	1	21.52	1.4
Baishao	MOL001801	salicy...	https:...	138.13	1.17	2	3	32.13	0.63
Baishao	MOL001888	2,2-di...	https:...	128.24	2.09	1	1	82.54	1.22
Baishao	MOL001889	Methyl...	https:...	294.53	6.64	0	2	41.93	1.46
Baishao	MOL001890	octade...	https:...	252.54	8.14	0	0	19.5	1.87
Baishao	MOL001891	9-meth...	https:...	178.24	3.55	0	0	26.87	1.95
Baishao	MOL001892	Diprop...	https:...	250.32	3.29	0	4	66.3	0.78
Baishao	MOL001893	BU3	https:...	90.14	-0.14	2	2	34.87	0.19
Baishao	MOL001894	Bicetyl	https:...	450.98	14.97	0	0	8.03	1.96
...	...	...	...	...	...	...	...	...	...

根据 OB、DL 筛选：

Figure 1 (下方图) 为图 Filterd TGP 概览。

(对应文件为 **Figure+Table/Filterd-TGP.pdf**)

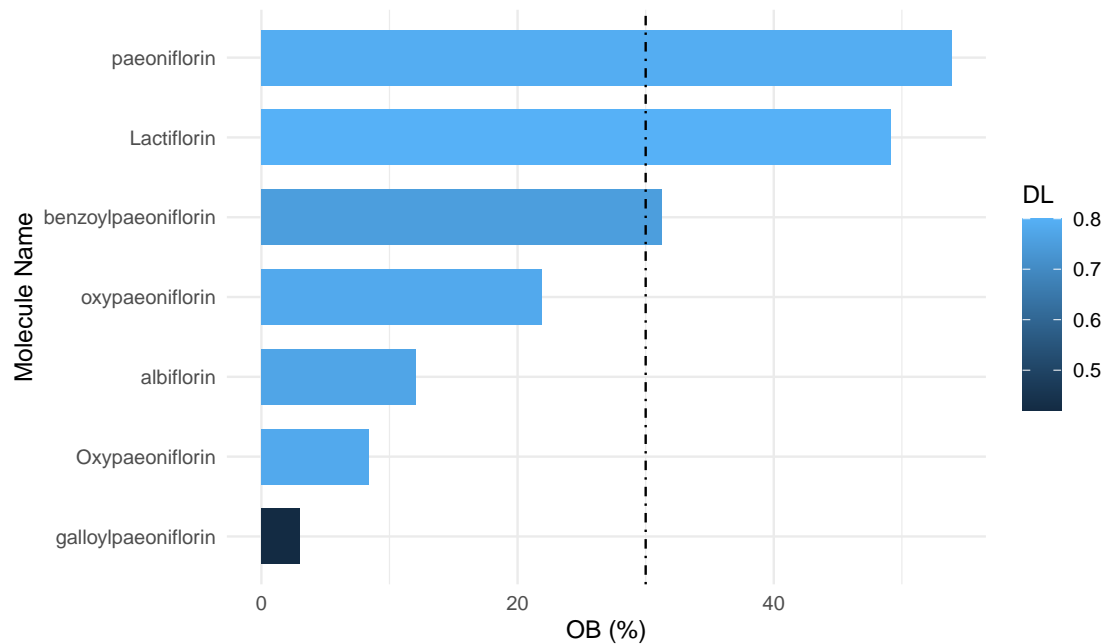


Figure 1: Filterd TGP

### 6.2.2 白芍总苷 (Total glucosides of paeony, TGP) 成分的靶点预测

通过 SwissTargetPrediction 预测靶点。

Figure 2 (下方图) 为图 SwissTargetPrediction results 概览。

(对应文件为 Figure+Table/SwissTargetPrediction-results.pdf)



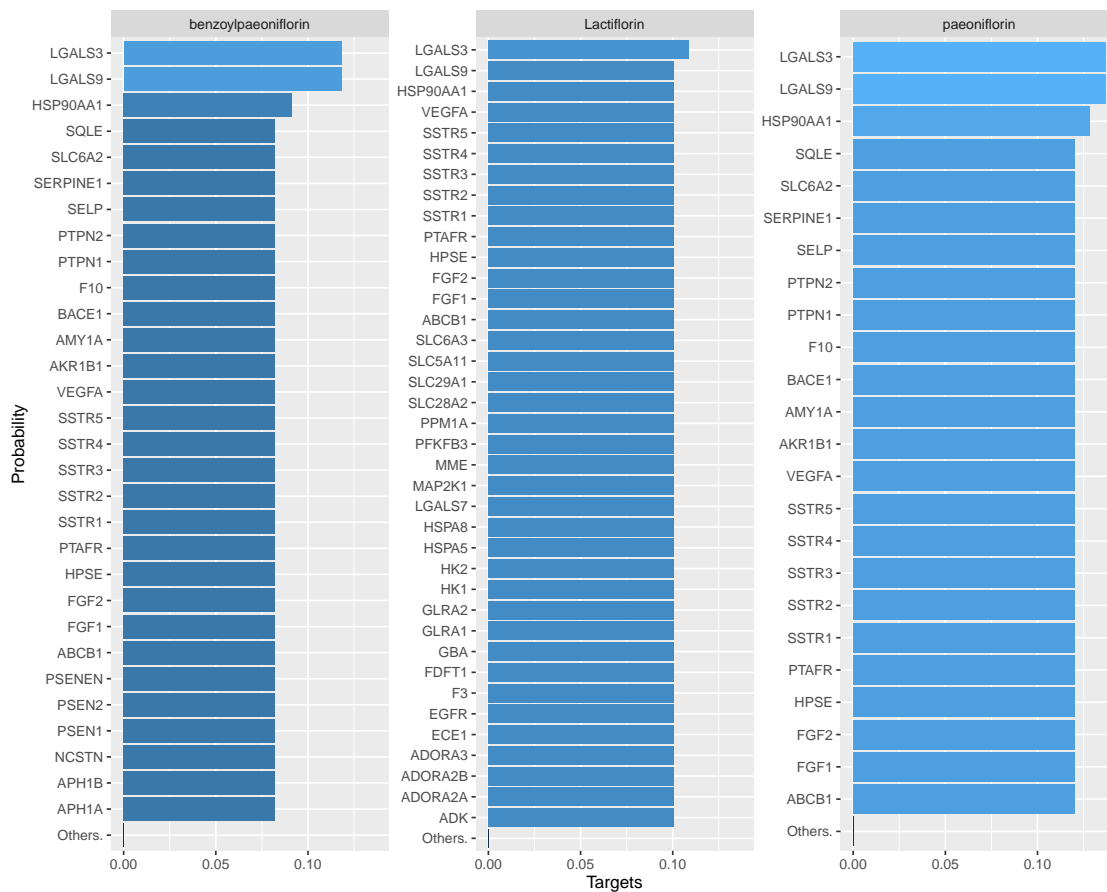


Figure 2: SwissTargetPrediction results

### 6.3 白芍总苷 (Total glucosides of paeony, TGP) 的网络药理学分析

#### 6.3.1 白芍总苷 (Total glucosides of paeony, TGP) 成分-靶点

Figure 3 (下方图) 为图 Network pharmacology visualization 概览。

(对应文件为 [Figure+Table/Network-pharmacology-visualization.pdf](#))

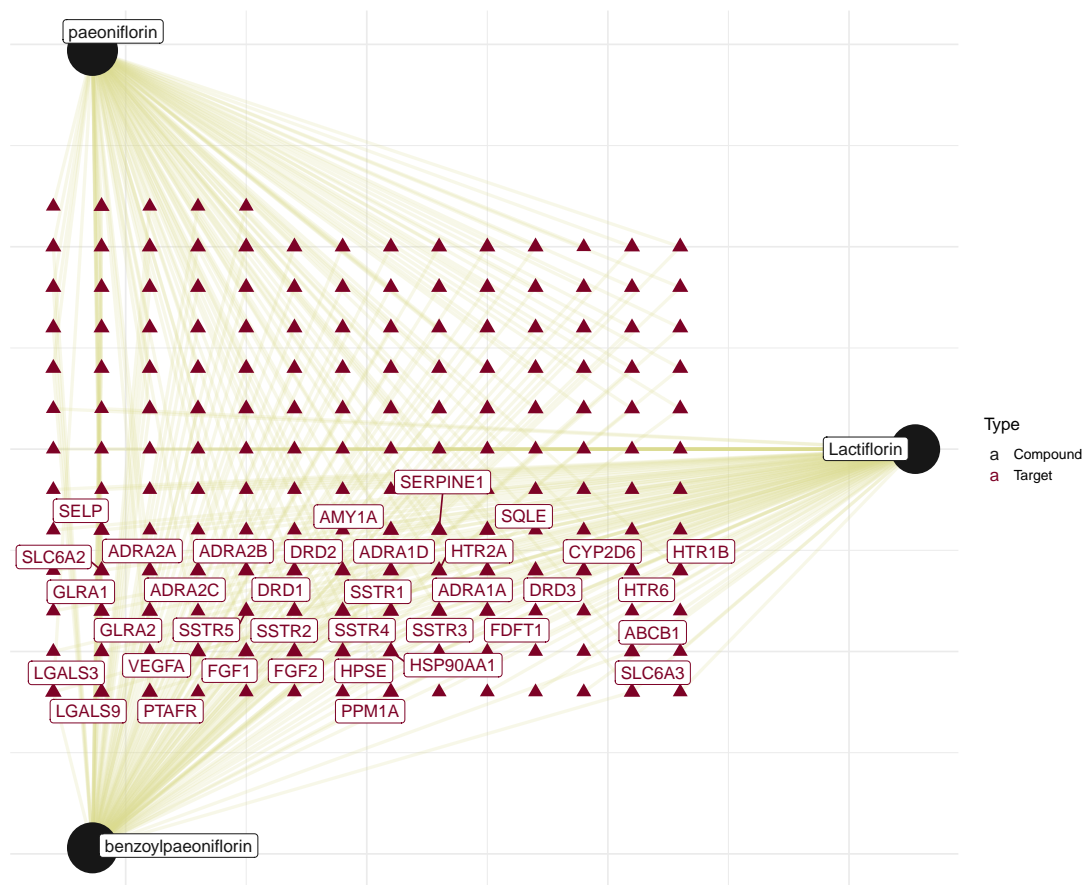


Figure 3: Network pharmacology visualization

### 6.3.2 白芍总苷 (Total glucosides of paeony, TGP) 和过敏性鼻炎 (allergic rhinitis, AR) 靶基因的交集

Figure 4 (下方图) 为图 Baishao TGP targets intersect with AR related targets 概览。

(对应文件为 Figure+Table/Baishao-TGP-targets-intersect-with-AR-related-targets.pdf)

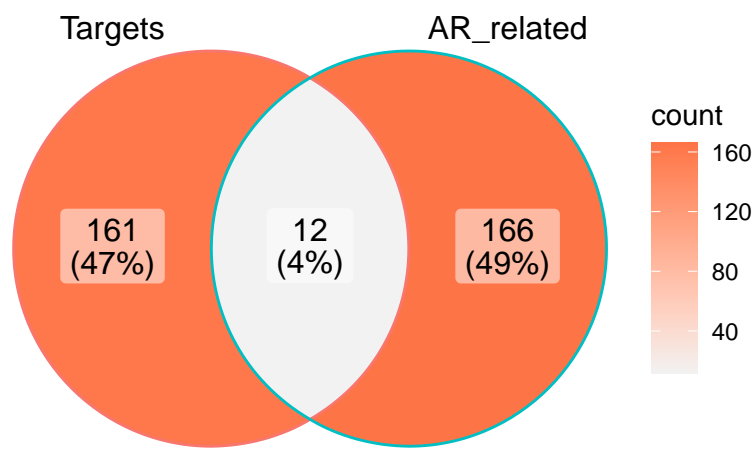


Figure 4: Baishao TGP targets intersect with AR related targets

**Intersection :**

LGALS3, EGFR, VEGFA, CYP2D6, SELP, SERPINE1, PIK3CG, MMP9, ITK, ADRB2, STAT3, PTGS2

(上述信息框内容已保存至 Figure+Table/Baishao-TGP-targets-intersect-with-AR-related-targets-content)

Figure 5 (下方图) 为图 Targets of compounds and related disease 概览。

(对应文件为 Figure+Table/Targets-of-compounds-and-related-disease.pdf)

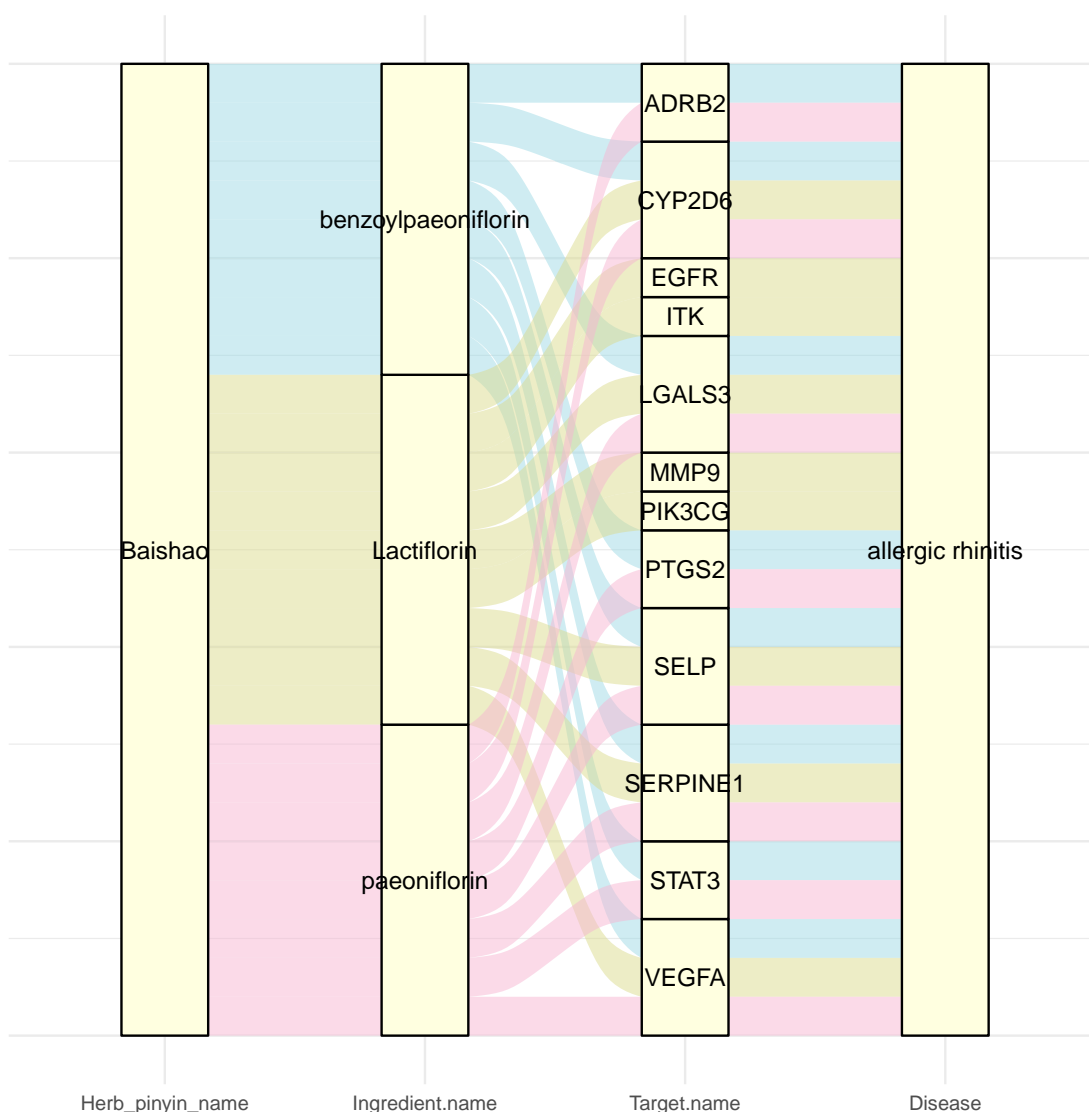


Figure 5: Targets of compounds and related disease

### 6.3.3 芍药苷 (Paeoniflorin, P) 和过敏性鼻炎 (allergic rhinitis, AR) 靶基因的交集

Figure 6 (下方图) 为图 Paeoniflorin targets intersect with AR related targets 概览。

(对应文件为 Figure+Table/Paeoniflorin-targets-intersect-with-AR-related-targets.pdf)

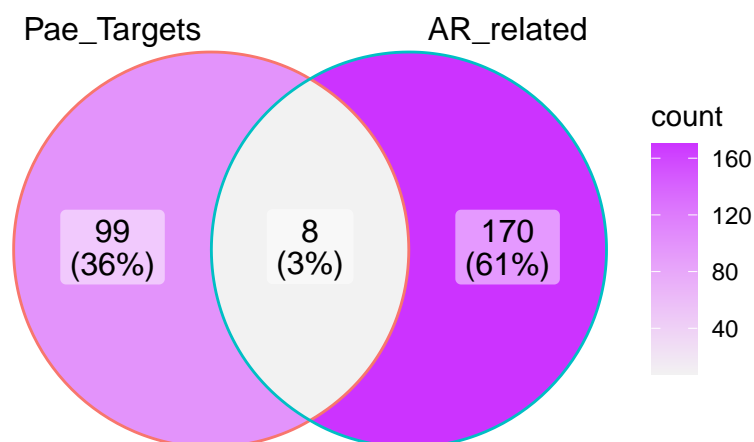


Figure 6: Paeoniflorin targets intersect with AR related targets

**Intersection :**

LGALS3, VEGFA, SERPINE1, SELP, ADRB2, CYP2D6, STAT3, PTGS2

(上述信息框内容已保存至 Figure+Table/Paeoniflorin-targets-intersect-with-AR-related-targets-content)

Figure 7 (下方图) 为图 Network pharmacology visualization of Paeoniflorin 概览。

(对应文件为 Figure+Table/Network-pharmacology-visualization-of-Paeoniflorin.pdf)

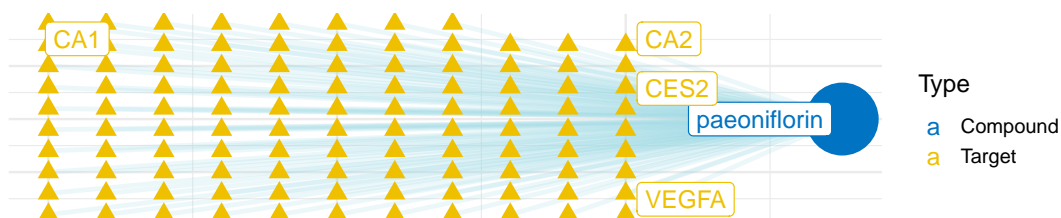


Figure 7: Network pharmacology visualization of Paeoniflorin

## 6.4 富集分析

### 6.4.1 白芍总苷 (Total glucosides of paeony, TGP) 与 AR 交集基因的富集分析

Figure 8 (下方图) 为图 TGP Interect genes KEGG enrichment 概览。

(对应文件为 Figure+Table/TGP-Interect-genes-KEGG-enrichment.pdf)

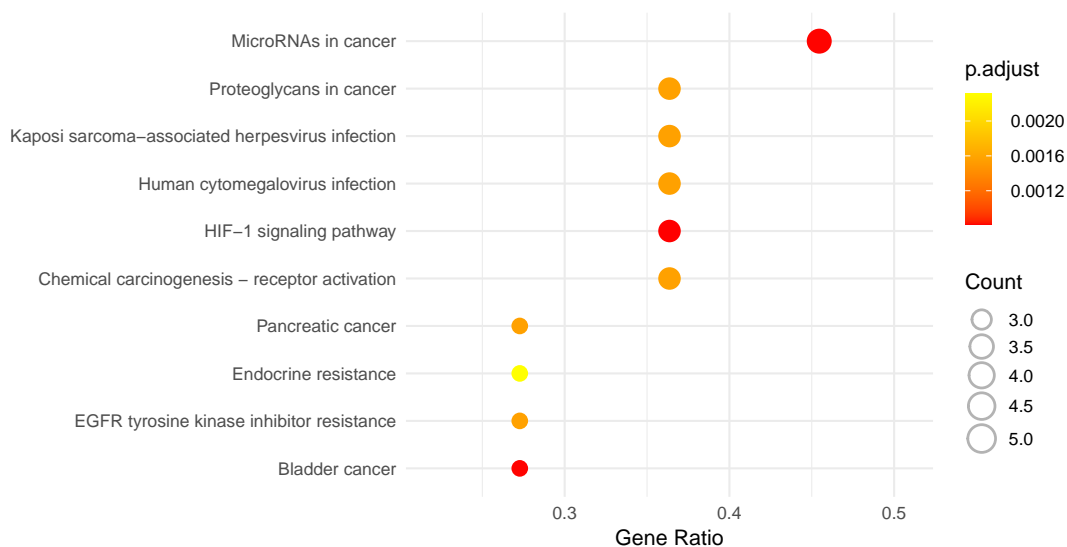


Figure 8: TGP Intersect genes KEGG enrichment

Figure 9 (下方图) 为图 TGP Intersect genes GO enrichment 概览。

(对应文件为 [Figure+Table/TGP-Intersect-genes-GO-enrichment.pdf](#))

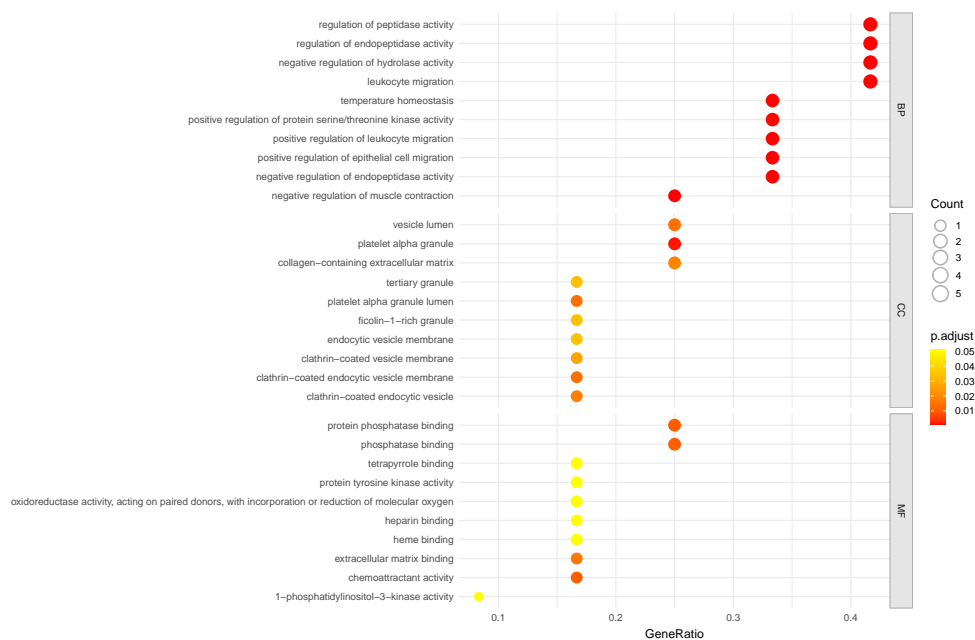


Figure 9: TGP Intersect genes GO enrichment

#### 6.4.2 芍药苷 (Paeoniflorin, P) 与 AR 交集基因的富集分析

Figure 10 (下方图) 为图 Pae Intersect genes KEGG enrichment 概览。

(对应文件为 [Figure+Table/Pae-Intersect-genes-KEGG-enrichment.pdf](#))

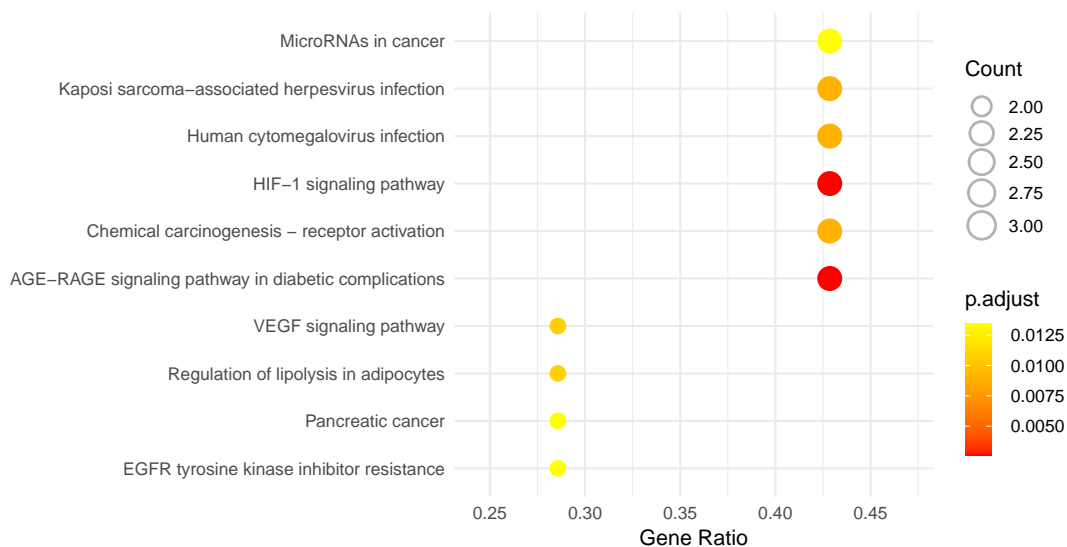


Figure 10: Pae Intersect genes KEGG enrichment

Figure 11 (下方图) 为图 Pae Intersect genes GO enrichment 概览。

(对应文件为 [Figure+Table/Pae-Intersect-genes-GO-enrichment.pdf](#))

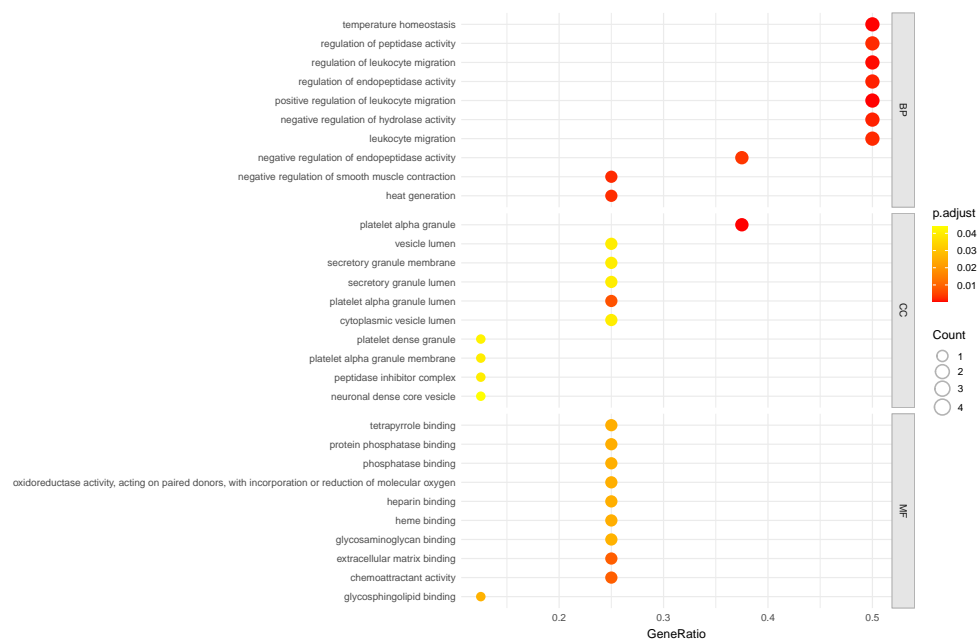


Figure 11: Pae Intersect genes GO enrichment

## 6.5 分子对接

对接的对象为: SOX18, USP5

### 6.5.1 芍药苷 (Paeoniflorin, P)

Figure 12 (下方图) 为图 Overall combining Affinity 概览。

(对应文件为 Figure+Table/Overall-combining-Affinity.pdf)

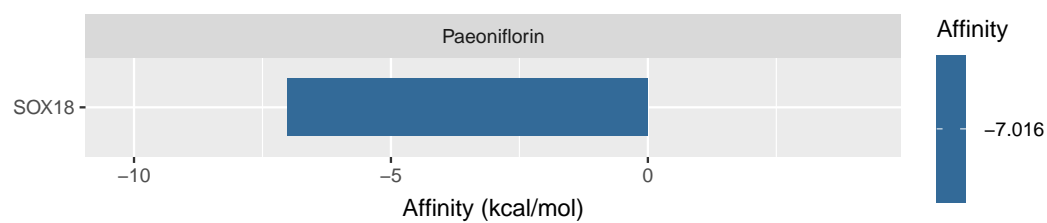


Figure 12: Overall combining Affinity

Figure 13 (下方图) 为图 Paeoniflorin combine USP5 概览。

(对应文件为 Figure+Table/442534\_into\_2dag.png)



Figure 13: Paeoniflorin combine USP5

Figure 14 (下方图) 为图 Paeoniflorin combine SOX18 概览。

(对应文件为 Figure+Table/442534\_into\_sox18.png)

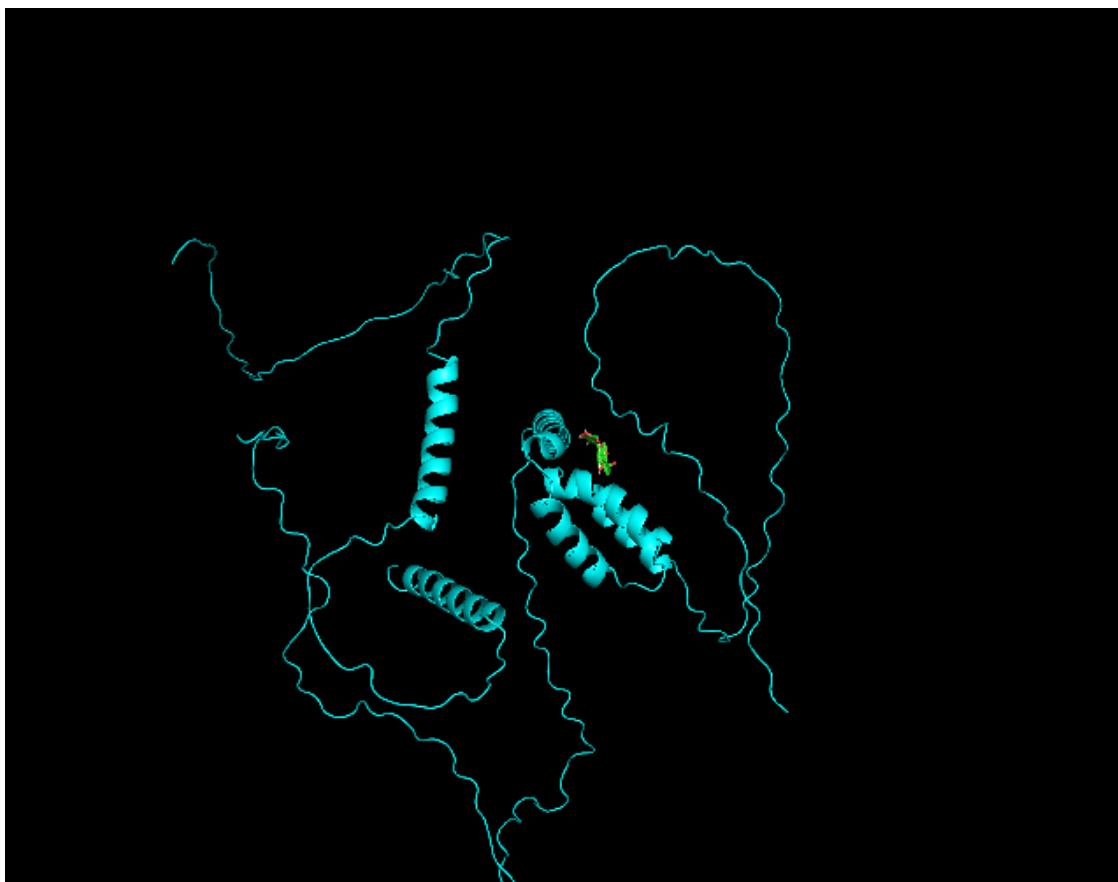


Figure 14: Paeoniflorin combine SOX18

## Reference

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2. Daina, A., Michielin, O. & Zoete, V. SwissTargetPrediction: Updated data and new features for efficient prediction of protein targets of small molecules. *Nucleic Acids Research* **47**, W357–W364 (2019).
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