

植物芥酸合成代谢中关键酶脂肪酸延长酶的结构分析预测

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致谢

背景及意义

- 芥酸在自然界中存在于十字花科芸苔属植物白芥(*Brassica alba*)种子脂肪及菜籽油中，含量颇高。芥酸是油菜籽中一种成分，是长链脂肪酸，人不易消化吸收，因此育种的一个目标就是降低菜籽中的芥酸含量，规定1%以下含量的菜籽为低芥酸菜籽，以低芥酸菜籽压榨的油为低芥酸菜籽油。
- 动物实验证明，大量摄入含芥酸高的菜籽油，动物心肌中脂肪积聚，并以甘油三酯的形式存在，可导致心肌纤维化。
- 油菜脂肪酸延长酶基因FAE1是广泛存在于植物中能催化脂肪酸碳链延长的酮脂酰CoA合成酶

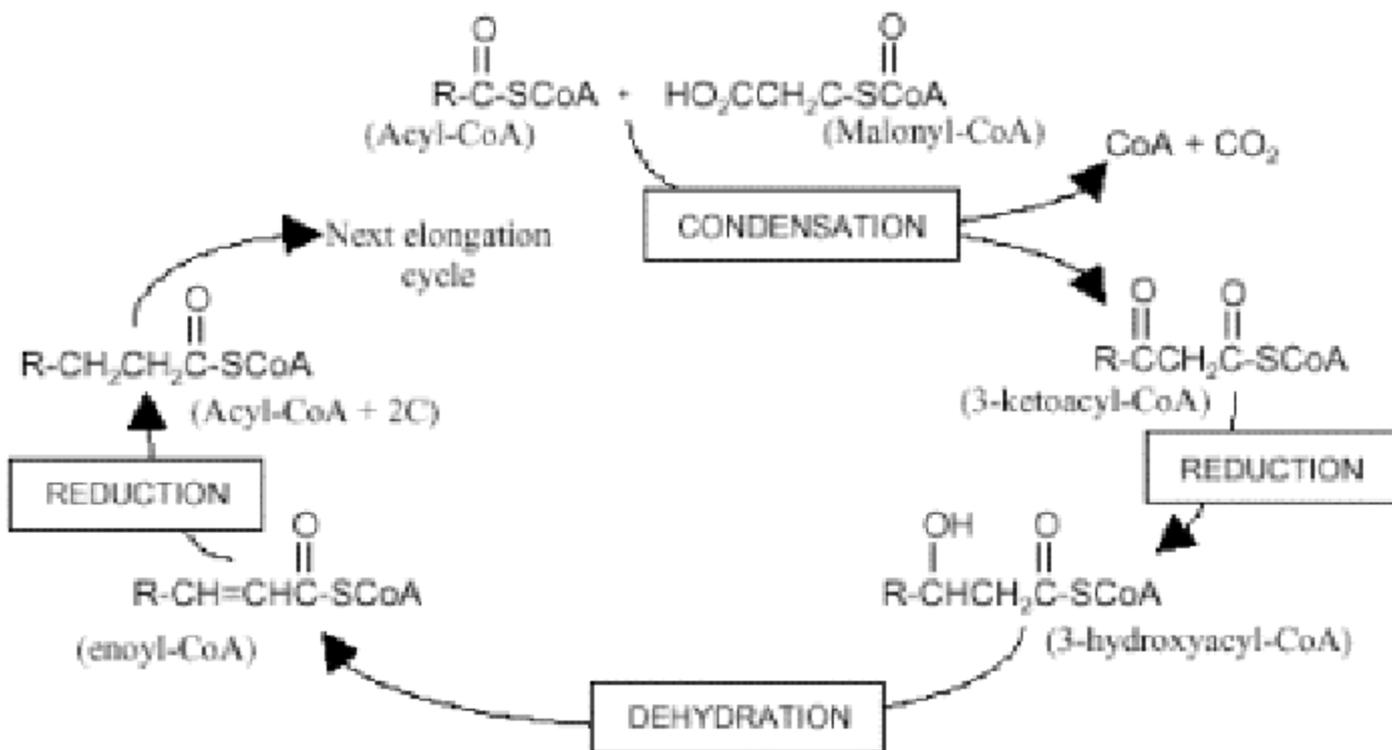


Fig. 1 Reactions of fatty acid elongation

本研究拟通过学到的生物信息学知识对油菜脂肪酸延长酶基因FAE1进行一些分析，期待对其能有更深入的了解，为本课题组做这方面研究的老师及同学予以借鉴。

方法步骤

- 从Uniprot中得到FAE1基因的蛋白序列
- 在predictProtein中进行二级结构预测
- 用MEGA寻找 FAE1氨基酸保守序列

从UniProt中得到FAE1基因的蛋白序列

Search

Blast

Align

Retrieve

ID Mapping *

Search in

Query

Protein Knowledgebase (UniProtKB)

AF490462

Search

Advanced

Clear

1 result for AF490462 in UniProtKB



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Reduce sequence redundancy to [100%](#), [90%](#) or [50%](#)

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Results [Customize](#)

Entry	Entry name	Status	Protein names	Gene names	Organism	Length
Q8S3A0	Q8S3A0_BRANA	★	3-ketoacyl-CoA synthase		Brassica napus (Rape)	506

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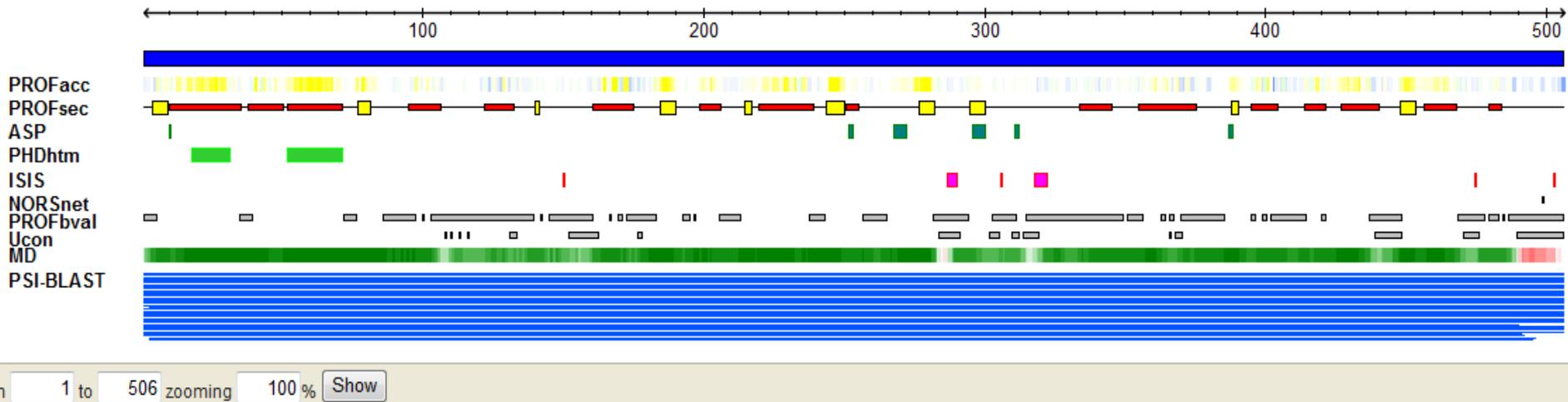
>tr|Q8S3A0|Q8S3A0_BRANA 3-ketoacyl-CoA synthase OS=Brassica napus PE=3
SV=1

MTSINVKLLYHYVITNLFNLCFFPLTAIVAGKAYRLTIDDLHHLYYSYLQHNLITIAPLF
AFTVFGSVLYIATRPKPVYLVEYSCYLPPTHCRSSISKVMDIFYQVRKADPSRNGTCDDS
SWLDFLRKIQERSGLGDETHGPEGLLQVPPRKTFAAAREETEQVIIGALENLFKNTNVNP
KDIGILVNSSMFNPTPSLSAMVVNTFKLRSNVRSFNLGGMGCSAGVIAIDLAKDLLHVH
KNTYALVVSTENITYNIYAGDNRSMMVSNCLFRVGGAAILLFNKPGDRRRSKYELVHTVR
THAGADDKSFRCVQQGDDENGKIGVSLSKDITDVAGRTVKKNIATLGPLILPLSEKLLFF
VTFMGKKLFDKIKHYYPDFKLAIDHFCIHAGGRAVIDVLEKNLALAPIDVEASRSTLH
RFGNTSSSSSIWYELAYIEAKGRMKKGNKWWQIALGSGFKCNSAVVVALNNVKASTNSPWE
HCIDRYPVKIDSDSGKSETRAQNGRS

脂肪酸延长酶二级结构分析

- Protein molecular=2687
- Chairs=1
- AA Number=506

在*predictProtein*中进行二级结构预测



Sequence length

506

Secondary structure

Helix=41.9%, Strand=9.9%, Loop=48.2%

Transmembrane

PHDhtm summary

- NHTM=2
PHDhtm detected 2 membrane helices for the **best** model. The second best model contained 1 helix.
- TOP=in
PHDhtm predicted the topology in, i.e. the first loop region is in (Note: this prediction may be problematic when the sequence you sent starts or ends with a region predicted in a membrane helix!)
- Reliability of best model=1 (0 is low, 9 is high)
- Zscore for best model=0.707
- Difference of positive charges (K+R) inside - outside=-4.500 (the higher the value, the more reliable)
- Reliability of topology prediction =4 (0 is low, 9 is high)
- Details of the strength of each predicted membrane helix:
(sorted by strength, strongest first)

N HTM	Total score	Best HTM	c-N
1	0.9476	0.8754	54 - 71
2	0.9594	0.6645	16 - 33

用MEGA寻找 FAE1氨基酸保守序列

- 方法:

Uniprot中查找FAE1（油菜）的氨基酸序列



在NCBI的blastp中寻找相似序列



高相似序列与 FAE1（油菜）在mega中作ClustalW



找出保守序列

FAE1氨基酸保守序列寻找

结果：在272-276部位保守性高

✓1. Q89340_BRANA_Brassica napu	V	V	N	S	S	M	F	N	P	T	P	S	L	S	A	M	V	V	N	T	F	K	L	R	S	N	V	R	S	F	N	L	G	G	M	G	C	S	A	G	V	I	A	I	D	L	A	K	D	L	L	H	V	H	K	N	T	Y	A	L	V	V	S	T	E	N
✓2. KCS9_ARATH	V	V	N	C	S	L	F	N	P	T	P	S	L	S	A	M	I	V	N	K	Y	K	L	R	G	N	V	K	S	F	N	L	G	G	M	G	C	S	A	G	V	I	S	I	D	L	A	K	D	M	L	Q	V	H	R	N	T	Y	A	V	V	V	S	T	E	N
✓3. KCS8_ARATH	V	V	N	S	S	T	F	N	P	T	P	S	L	A	S	M	I	V	N	K	Y	K	L	R	D	N	I	K	S	L	N	L	G	G	M	G	C	S	A	G	V	I	A	V	D	V	A	K	G	L	L	Q	V	H	R	N	T	Y	A	I	V	V	S	T	E	N
✓4. KCS7_ARATH	V	S	N	C	S	L	F	C	P	S	P	S	I	T	S	M	I	I	N	K	F	G	M	R	S	D	I	K	S	F	S	L	S	G	M	G	C	S	A	G	I	L	S	V	N	L	V	K	D	L	M	K	I	H	G	D	S	L	A	L	V	L	S	M	E	A
✓5. KCS98_ARATH	I	V	N	C	S	L	F	S	P	T	P	S	L	S	A	M	V	I	N	K	Y	K	L	R	S	N	I	K	S	F	N	L	S	G	M	G	C	S	A	G	L	I	S	V	D	L	A	R	D	L	L	Q	V	H	P	N	S	N	A	I	I	V	S	T	E	N
✓6. KCS5_ARATH	I	V	N	C	S	L	F	S	P	T	P	S	L	S	A	M	I	I	N	K	Y	K	L	R	S	N	I	K	S	Y	N	L	S	G	M	G	C	S	A	S	L	I	S	V	D	V	A	R	D	L	L	Q	V	H	P	N	S	N	A	I	I	S	T	E	N	
✓7. KCS4_ARATH	V	V	N	C	S	L	F	N	P	T	P	S	L	S	A	M	I	V	N	K	Y	K	L	R	G	N	I	R	S	Y	N	L	G	G	M	G	C	S	A	G	V	I	A	V	D	L	A	K	D	M	L	L	V	H	R	N	T	Y	A	V	V	V	S	T	E	N
✓8. KCS3_ARATH	V	V	N	V	S	M	L	N	S	T	P	S	L	S	A	R	I	I	N	H	Y	K	M	R	E	D	I	K	V	F	N	L	T	A	M	G	C	S	A	S	V	I	S	I	D	I	V	K	N	I	F	K	T	Y	K	N	K	L	A	L	V	V	T	S	E	S
✓9. KCS20_ARATH	I	T	N	C	S	L	H	S	P	S	P	S	L	S	A	M	V	I	N	K	F	H	M	R	S	N	I	K	S	F	N	L	S	G	M	G	C	A	A	G	I	L	S	V	N	L	A	N	D	L	L	Q	A	H	R	G	S	L	A	L	I	V	S	T	E	N
✓10. KCS2_ARATH	V	V	N	C	S	L	F	N	P	T	P	S	L	S	A	M	I	V	N	K	Y	K	L	R	G	N	I	K	S	F	N	L	G	G	M	G	C	S	A	G	V	I	A	V	D	L	A	S	D	M	L	Q	I	H	R	N	T	F	A	L	V	V	S	T	E	N
✓11. KCS19_ARATH	V	V	N	C	S	L	F	N	P	T	P	S	L	S	A	M	I	V	N	K	Y	K	L	R	G	N	I	L	S	Y	N	L	G	G	M	G	C	S	A	G	L	I	S	I	D	L	A	K	Q	M	L	Q	V	Q	P	N	S	Y	A	L	V	V	S	T	E	N
✓12. KCS18_ARATH	V	V	N	S	S	M	F	N	P	T	P	S	L	S	A	M	V	V	N	T	F	K	L	R	S	N	I	K	S	F	N	L	G	G	M	G	C	S	A	G	V	I	A	I	D	L	A	K	D	L	L	H	V	H	K	N	T	Y	A	L	V	V	S	T	E	N
✓13. KCS17_ARATH	V	V	N	C	S	L	F	N	P	T	P	S	L	S	A	M	I	V	N	K	Y	K	L	R	G	N	V	L	S	Y	N	L	G	G	M	G	C	S	A	G	L	I	S	I	D	L	A	K	Q	L	L	Q	V	Q	P	N	S	Y	A	L	V	V	S	T	E	N
✓14. KCS16_ARATH	V	V	N	S	S	T	F	N	P	T	P	S	L	S	S	I	L	V	N	K	F	K	L	R	D	N	I	K	S	L	N	L	G	G	M	G	C	S	A	G	V	I	A	I	D	A	A	K	S	L	L	Q	V	H	R	N	T	Y	A	L	V	V	S	T	E	N
✓15. KCS15_ARATH	V	L	N	C	G	V	L	N	T	T	P	S	L	S	A	M	V	I	N	H	Y	K	L	R	H	N	T	E	S	Y	N	L	G	G	M	G	C	S	A	G	V	I	A	I	D	L	A	K	D	L	L	N	A	H	Q	G	S	Y	A	L	V	V	S	T	E	N
✓16. KCS14_ARATH	I	V	N	C	S	L	F	N	P	N	P	S	L	S	S	M	I	V	N	R	Y	K	L	K	T	D	V	K	T	Y	N	L	S	G	-	-	-	-	-	I	S	V	D	L	A	T	N	L	L	K	A	N	P	N	T	Y	A	V	I	V	S	T	E	N		
✓17. KCS13_ARATH	I	V	N	C	S	L	F	N	P	N	P	S	L	S	S	M	I	V	N	R	Y	K	L	K	T	D	V	K	T	Y	N	L	S	G	M	G	C	S	A	G	A	I	S	V	D	L	A	T	N	L	L	K	A	N	P	N	T	Y	A	V	I	V	S	T	E	N
✓18. KCS12_ARATH	V	V	N	V	S	M	L	S	S	T	P	S	L	A	S	R	I	I	N	H	Y	K	M	R	D	D	V	K	V	F	N	L	T	G	M	G	C	S	A	S	L	I	S	V	D	I	V	K	N	I	F	K	S	Y	A	N	K	L	A	L	V	A	T	S	E	S
✓19. KCS11_ARATH	I	V	N	C	S	L	F	N	P	T	P	S	L	S	A	M	V	V	N	H	Y	K	L	R	G	N	I	L	S	Y	N	L	G	G	M	G	C	S	A	G	L	I	S	I	D	L	A	K	H	L	L	H	S	I	P	N	T	Y	A	M	V	I	S	M	E	N
✓20. KCS10_ARATH	V	V	N	C	S	I	F	N	P	T	P	S	L	S	A	M	V	I	N	H	Y	K	M	R	G	N	I	L	S	Y	N	L	G	G	M	G	C	S	A	G	I	I	A	I	D	L	A	R	D	M	L	Q	S	N	P	N	S	Y	A	V	V	V	S	T	E	N
✓21. KCS1_ARATH	I	V	N	C	S	L	F	N	P	T	P	S	L	S	A	M	I	V	N	H	Y	K	M	R	E	D	I	K	S	Y	N	L	G	G	M	G	C	S	A	G	L	I	S	I	D	L	A	N	N	L	L	K	A	N	P	N	S	Y	A	V	V	V	S	T	E	N

结果：在320-329部位保守性高

✓ 1. Q8S340_BRANA_Brassica napu	T	E	N	I	T	Y	N	I	Y	A	G	D	N	R	S	M	M	V	S	N	C	L	F	R	V	G	G	A	A	I	L	L	F	N	K	P	G	D	R	R	R	S	K	Y	E	L	V	H	T	V	R	T	H	A	G	A	D	D	K	S	F	R	C	V	Q	Q	G
✓ 2. KCS9_ARATH	T	E	N	I	T	Q	N	W	Y	F	G	N	K	K	A	M	L	I	P	N	C	L	F	R	V	G	G	S	A	I	L	L	S	N	K	G	K	D	R	R	R	S	K	Y	K	L	V	H	T	V	R	T	H	K	G	A	V	E	K	A	F	N	C	V	Y	Q	E
✓ 3. KCS8_ARATH	T	E	N	I	T	Q	N	L	Y	L	G	K	N	K	S	M	L	V	T	N	C	L	F	R	V	G	G	A	A	V	L	L	S	N	R	S	R	D	R	N	R	A	K	Y	E	L	V	H	T	V	R	I	H	T	G	S	D	D	R	S	F	E	C	A	T	Q	E
✓ 4. KCS7_ARATH	M	E	A	V	S	P	N	G	Y	R	G	K	C	K	S	M	L	I	A	N	T	I	F	R	M	G	G	A	A	I	L	L	S	N	R	K	Q	D	S	H	K	A	K	Y	K	L	Q	H	I	I	R	T	H	V	G	S	D	T	E	S	Y	E	S	V	M	Q	Q
✓ 5. KCS8_ARATH	T	E	I	I	T	P	N	Y	Y	Q	G	N	E	R	A	M	L	L	P	N	C	L	F	R	M	G	A	A	A	I	H	M	S	N	R	R	S	D	R	W	R	A	K	Y	K	L	S	H	L	V	R	T	H	R	G	A	D	D	K	S	F	Y	C	V	Y	E	Q
✓ 6. KCS5_ARATH	T	E	I	I	T	P	N	Y	Y	K	G	N	E	R	A	M	L	L	P	N	C	L	F	R	M	G	G	A	A	I	L	L	S	N	R	R	S	D	R	W	R	A	K	Y	K	L	C	H	L	V	R	T	H	R	G	A	D	D	K	S	Y	N	C	V	M	E	Q
✓ 7. KCS4_ARATH	T	E	N	I	T	Q	N	W	Y	F	G	N	K	K	S	M	L	I	P	N	C	L	F	R	V	G	G	S	A	V	L	L	S	N	K	S	R	D	K	R	R	S	K	Y	R	L	V	H	V	V	R	T	H	R	G	A	D	D	K	A	F	R	C	V	Y	Q	E
✓ 8. KCS3_ARATH	S	E	S	L	S	P	N	W	Y	S	G	N	N	R	S	M	I	L	A	N	C	L	F	R	S	G	G	C	A	V	L	L	T	N	K	R	S	L	S	R	R	A	M	F	K	L	R	C	L	V	R	T	H	H	G	A	R	D	D	S	F	N	A	C	V	Q	K
✓ 9. KCS20_ARATH	T	E	A	L	N	T	H	W	Y	I	G	K	D	R	S	M	L	L	T	N	C	L	F	R	M	G	A	A	A	V	L	M	S	S	N	D	H	D	R	D	N	A	K	Y	E	L	L	H	V	V	R	K	N	K	A	K	D	D	R	A	Y	R	C	I	Y	Q	D
✓ 10. KCS2_ARATH	T	E	N	I	T	Q	N	W	Y	F	G	N	K	K	A	M	L	I	P	N	C	L	F	R	V	G	G	S	A	V	L	L	S	N	K	P	L	D	R	K	R	S	K	Y	K	L	V	H	T	V	R	T	H	K	G	S	D	E	N	A	F	N	C	V	Y	Q	E
✓ 11. KCS19_ARATH	T	E	N	I	T	L	N	W	Y	L	G	N	D	R	S	M	L	L	S	N	C	I	F	R	M	G	G	A	A	V	L	L	S	N	R	S	S	D	R	S	R	S	K	Y	Q	L	I	H	T	V	R	T	H	K	G	A	D	D	N	A	F	G	C	V	Y	Q	R
✓ 12. KCS18_ARATH	T	E	N	I	T	Q	G	I	Y	A	G	E	N	R	S	M	M	V	S	N	C	L	F	R	V	G	G	A	A	I	L	L	S	N	K	S	G	D	R	R	R	S	K	Y	K	L	V	H	T	V	R	T	H	T	G	A	D	D	K	S	F	R	C	V	Q	Q	E
✓ 13. KCS17_ARATH	T	E	N	I	T	L	N	W	Y	L	G	N	D	R	S	M	L	L	S	N	C	I	F	R	M	G	G	A	A	V	L	L	S	N	R	S	S	D	R	C	R	S	K	Y	Q	L	I	H	T	V	R	T	H	K	G	S	D	D	N	A	F	N	C	V	Y	Q	R
✓ 14. KCS16_ARATH	T	E	N	I	T	Q	N	L	Y	M	G	N	N	K	S	M	L	V	T	N	C	L	F	R	I	G	G	A	A	I	L	L	S	N	R	S	I	D	R	K	R	A	K	Y	E	L	V	H	T	V	R	V	H	T	G	A	D	D	R	S	Y	E	C	A	T	Q	E
✓ 15. KCS15_ARATH	T	E	I	V	S	F	T	W	Y	S	G	N	D	V	A	L	L	P	P	N	C	F	F	R	M	G	A	A	A	V	M	L	S	S	R	R	I	D	R	W	R	A	K	Y	Q	L	M	Q	L	V	R	T	H	K	G	M	E	D	T	S	Y	K	S	I	E	L	R
✓ 16. KCS14_ARATH	T	E	N	M	T	L	S	M	Y	R	G	N	D	R	S	M	L	V	P	N	C	L	F	R	V	G	G	A	A	V	M	L	S	N	R	S	Q	D	R	V	R	S	K	Y	E	L	T	H	I	V	R	T	H	K	G	S	S	D	K	H	Y	T	C	A	E	Q	K
✓ 17. KCS13_ARATH	T	E	N	M	T	L	S	M	Y	R	G	N	D	R	S	M	L	V	P	N	C	L	F	R	V	G	G	A	A	V	M	L	S	N	R	S	Q	D	R	V	R	S	K	Y	E	L	T	H	I	V	R	T	H	K	G	S	S	D	K	H	Y	T	C	A	E	Q	K
✓ 18. KCS12_ARATH	S	E	S	L	S	P	N	W	Y	S	G	N	N	R	S	M	I	L	A	N	C	L	F	R	S	G	G	C	A	I	L	L	T	N	K	R	S	L	R	K	K	A	M	F	K	L	K	C	M	V	R	T	H	H	G	A	R	E	E	S	Y	N	C	I	Q	A	
✓ 19. KCS11_ARATH	M	E	N	I	T	L	N	W	Y	F	G	N	D	R	S	K	L	V	S	N	C	L	F	R	M	G	G	A	A	I	L	L	S	N	K	R	W	D	R	R	R	S	K	Y	E	L	V	D	T	V	R	T	H	K	G	A	D	D	K	C	F	G	C	I	T	Q	E
✓ 20. KCS10_ARATH	T	E	M	V	G	Y	N	W	Y	V	G	S	D	K	S	M	V	I	P	N	C	F	F	R	M	G	C	S	A	V	M	L	S	N	R	R	D	F	R	H	A	K	Y	R	L	E	H	I	V	R	T	H	K	A	A	D	D	R	S	F	R	S	V	Y	Q	E	
✓ 21. KCS1_ARATH	T	E	N	I	T	L	N	W	Y	F	G	N	D	R	S	M	L	L	C	N	C	I	F	R	M	G	G	A	A	I	L	L	S	N	R	Q	D	R	K	K	S	K	Y	S	L	V	N	V	V	R	T	H	K	G	S	D	D	K	N	Y	N	C	V	Y	Q	K	

结果：在498-518部位保守性高

<input checked="" type="checkbox"/> 1. Q8S340_BRANA_Brassica napu	V	P	D	F	K	L	A	I	D	H	F	C	I	H	A	G	G	R	A	V	I	D	V	L	E	K	N	L	A	L	A	P	I	D	V	E	A	S	R	S	T	L	H	R	F	G	N	T	S	S	S	S	I	W	Y	E	L	A	Y	I	E	A	K	G	R	M	K
<input checked="" type="checkbox"/> 2. KCS9_ARATH	I	P	D	F	K	L	A	F	D	H	F	C	I	H	A	G	G	R	A	V	I	D	E	L	E	K	N	L	Q	L	S	Q	T	H	V	E	A	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	I	W	Y	E	L	A	Y	I	E	A	K	G	R	M	K
<input checked="" type="checkbox"/> 3. KCS8_ARATH	T	P	D	F	K	L	A	F	E	H	F	C	I	H	A	G	G	R	A	L	I	D	E	L	E	K	N	L	K	L	S	P	L	H	V	E	A	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	I	W	Y	E	L	A	Y	T	E	A	K	G	R	M	K
<input checked="" type="checkbox"/> 4. KCS7_ARATH	T	P	N	F	K	K	A	F	E	H	F	C	I	H	A	G	G	R	A	I	I	E	G	V	E	K	H	L	K	L	D	K	E	D	V	E	A	S	R	S	T	L	Y	R	Y	G	N	T	S	S	S	S	L	W	Y	E	L	Q	Y	L	E	A	K	G	R	M	K
<input checked="" type="checkbox"/> 5. KCS6_ARATH	I	P	D	F	K	L	A	F	E	H	F	C	I	H	A	G	G	R	A	V	I	D	E	L	Q	K	N	L	Q	L	S	G	E	H	V	E	A	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	L	W	Y	E	L	S	Y	I	E	S	K	G	R	M	R
<input checked="" type="checkbox"/> 6. KCS5_ARATH	I	P	D	F	K	Q	A	F	E	H	F	C	I	H	A	G	G	R	A	V	I	D	E	L	Q	K	N	L	Q	L	S	G	E	H	V	E	A	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	L	W	Y	E	L	S	Y	I	E	A	Q	G	R	M	K
<input checked="" type="checkbox"/> 7. KCS4_ARATH	I	P	D	F	K	L	A	F	E	H	F	C	I	H	A	G	G	R	A	V	I	D	E	L	E	K	N	L	Q	L	S	P	V	H	V	E	A	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	I	W	Y	E	L	A	Y	I	E	A	K	G	R	M	R
<input checked="" type="checkbox"/> 8. KCS3_ARATH	G	I	N	F	K	T	G	I	D	H	F	C	I	H	T	G	G	K	A	V	I	D	A	I	G	Y	S	L	D	L	N	E	Y	D	L	E	P	A	R	M	T	L	H	R	F	G	N	T	S	A	S	S	L	W	Y	V	L	G	Y	M	E	A	K	K	R	L	K
<input checked="" type="checkbox"/> 9. KCS20_ARATH	T	P	N	F	K	T	A	F	E	H	F	C	I	H	T	G	G	R	A	V	I	Q	A	M	E	M	N	L	K	L	T	K	V	D	I	E	P	S	K	M	T	L	H	R	F	G	N	T	S	S	S	S	I	W	Y	A	L	S	Y	L	E	A	K	R	R	M	K
<input checked="" type="checkbox"/> 10. KCS2_ARATH	I	P	D	F	K	L	A	L	D	H	F	C	I	H	A	G	G	R	A	V	I	D	E	L	E	K	S	L	K	L	S	P	K	H	V	E	A	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	I	W	Y	E	L	A	Y	T	E	A	K	G	R	M	R
<input checked="" type="checkbox"/> 11. KCS19_ARATH	I	P	D	F	K	L	A	F	E	H	F	C	I	H	A	G	G	R	A	V	L	D	E	I	E	K	N	L	D	L	S	E	W	H	M	E	P	S	R	M	T	L	N	R	F	G	N	T	S	S	S	S	L	W	Y	E	L	A	Y	S	E	A	K	G	R	I	K
<input checked="" type="checkbox"/> 12. KCS18_ARATH	V	P	D	F	K	L	A	V	D	H	F	C	I	H	A	G	G	R	A	V	I	D	E	L	E	K	N	L	G	L	S	P	I	D	V	E	A	S	R	S	T	L	H	R	F	G	N	T	S	S	S	S	I	W	Y	E	L	A	Y	I	E	A	K	G	R	M	K
<input checked="" type="checkbox"/> 13. KCS17_ARATH	I	P	D	F	K	L	A	F	E	H	F	C	I	H	A	G	G	R	A	V	L	D	E	I	E	K	N	L	D	L	S	E	W	H	M	E	P	S	R	M	T	L	N	R	F	G	N	T	S	S	S	S	L	W	Y	E	L	A	Y	S	E	A	K	G	R	I	K
<input checked="" type="checkbox"/> 14. KCS16_ARATH	I	P	D	F	K	L	A	F	E	H	F	C	I	H	A	G	G	R	A	L	I	D	E	M	E	K	N	L	H	L	T	P	L	D	V	E	A	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	I	W	Y	E	L	A	Y	T	E	A	K	G	R	M	T
<input checked="" type="checkbox"/> 15. KCS15_ARATH	-	-	-	-	-	S	F	E	H	I	C	V	L	A	S	S	K	K	V	L	D	D	I	H	K	D	L	K	L	T	E	E	N	M	E	A	S	R	R	T	L	E	R	F	G	N	T	S	S	S	S	I	W	Y	E	L	A	Y	L	E	H	K	A	K	M	K	
<input checked="" type="checkbox"/> 16. KCS14_ARATH	V	P	D	F	K	L	C	F	K	H	F	C	I	H	A	G	G	R	A	L	L	D	A	V	E	K	G	L	G	L	S	E	F	D	L	E	P	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	L	W	Y	E	L	A	Y	V	E	A	K	C	R	V	K
<input checked="" type="checkbox"/> 17. KCS13_ARATH	V	P	D	F	K	L	C	F	K	H	F	C	I	H	A	G	G	R	A	L	L	D	A	V	E	K	G	L	G	L	S	E	F	D	L	E	P	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	L	W	Y	E	L	A	Y	V	E	A	K	C	R	V	K
<input checked="" type="checkbox"/> 18. KCS12_ARATH	G	I	N	F	K	T	G	I	E	H	F	C	I	H	T	G	G	K	A	V	I	D	G	I	G	H	S	L	D	L	N	E	Y	D	I	E	P	A	R	M	T	L	H	R	F	G	N	T	S	A	S	S	L	W	Y	V	L	A	Y	M	E	A	K	K	R	L	K
<input checked="" type="checkbox"/> 19. KCS11_ARATH	I	P	D	F	K	L	A	F	E	H	F	C	I	H	A	G	G	R	A	V	L	D	E	L	E	K	N	L	K	L	T	E	W	H	M	E	P	S	R	M	T	L	Y	R	F	G	N	T	S	S	S	S	L	W	Y	E	L	A	Y	S	E	A	K	G	R	I	K
<input checked="" type="checkbox"/> 20. KCS10_ARATH	I	P	D	Y	K	L	A	F	E	H	F	C	F	H	A	A	S	K	V	V	L	E	E	L	Q	K	N	L	G	L	S	E	E	N	M	E	A	S	R	M	T	L	H	R	F	G	N	T	S	S	S	G	I	W	Y	E	L	A	Y	M	E	A	K	E	S	V	R
<input checked="" type="checkbox"/> 21. KCS1_ARATH	I	P	D	F	K	L	A	F	E	H	F	C	I	H	A	G	G	R	A	V	L	D	E	V	Q	K	N	L	D	L	K	D	W	H	M	E	P	S	R	M	T	L	H	R	F	G	N	T	S	S	S	S	L	W	Y	E	M	A	Y	T	E	A	K	G	R	V	K

结果：在535-545部位保守性高

✓ 1. Q8S3A0_BRANA_Brassica napu	K	G	N	K	V	W	Q	I	A	L	G	S	G	F	K	C	N	S	A	V	W	V	A	L	N	N	V	K	A	S	T	N	S	-	-	-	-	-	P	W	E	H	C	I	D	R	Y	P	V	K	I	D	S	D	S	G	K		
✓ 2. KCS9_ARATH	K	G	N	R	V	W	Q	I	A	F	G	S	G	F	K	C	N	S	A	V	W	V	A	L	N	N	V	K	P	S	V	S	S	-	-	-	-	-	P	W	E	H	C	I	D	R	Y	P	V	K	L	D	F	-	-	-	-		
✓ 3. KCS8_ARATH	E	G	D	R	I	W	Q	I	A	L	G	S	G	F	K	C	N	S	S	V	W	V	A	L	R	D	V	K	P	S	A	N	S	-	-	-	-	-	P	W	E	D	C	M	D	R	Y	P	V	E	I	D	I	-	-	-	-		
✓ 4. KCS7_ARATH	M	G	D	K	V	W	Q	I	G	F	G	S	G	F	K	A	N	S	A	V	W	K	C	I	S	E	I	D	S	R	G	R	N	-	-	-	-	-	A	W	S	D	R	I	H	L	Y	P	V	C	G	D	T	S	S	A	L		
✓ 5. KCS6_ARATH	R	G	D	R	V	W	Q	I	A	F	G	S	G	F	K	C	N	S	A	V	W	K	C	N	R	T	I	K	T	P	K	D	G	-	-	-	-	-	P	W	S	D	C	I	D	R	Y	P	V	F	I	P	E	V	V	K	L		
✓ 6. KCS5_ARATH	R	N	D	R	V	W	Q	I	A	F	G	S	G	F	K	C	N	S	A	V	W	K	C	N	R	T	I	K	T	P	T	D	G	-	-	-	-	-	A	W	S	D	C	I	E	R	Y	P	V	F	I	P	E	V	V	K	L		
✓ 7. KCS4_ARATH	R	G	N	R	V	W	Q	I	A	F	G	S	G	F	K	C	N	S	A	I	W	E	A	L	R	H	V	K	P	S	N	N	S	-	-	-	-	-	P	W	E	D	C	I	D	K	Y	P	V	T	L	S	Y	-	-	-	-		
✓ 8. KCS3_ARATH	R	G	D	R	V	F	M	I	S	F	G	A	G	F	K	C	N	S	C	V	W	E	V	V	R	D	L	N	V	G	E	A	V	G	N	-	-	-	-	-	V	W	N	H	C	I	N	Q	Y	P	P	K	S	I	L	N	P	F	F
✓ 9. KCS20_ARATH	K	G	D	R	V	L	Q	I	A	F	G	S	G	F	K	C	N	S	A	V	W	R	C	I	R	K	V	E	P	N	T	E	N	-	-	-	-	-	K	W	L	D	F	I	D	S	Y	P	V	D	V	P	D	S	T	N	I		
✓ 10. KCS2_ARATH	K	G	N	R	V	W	Q	I	A	F	G	S	G	F	K	C	N	S	A	V	W	V	A	L	R	N	V	E	P	S	V	N	N	-	-	-	-	-	P	W	E	H	C	I	H	R	Y	P	V	K	I	D	L	-	-	-	-		
✓ 11. KCS19_ARATH	R	G	D	R	T	W	Q	I	A	F	G	S	G	F	K	C	N	S	A	V	W	K	A	L	R	T	I	D	P	M	D	E	K	-	-	-	-	-	T	N	P	W	I	D	E	I	D	D	F	P	V	Q	V	P	R	I	T	P	I
✓ 12. KCS18_ARATH	K	G	N	K	A	W	Q	I	A	L	G	S	G	F	K	C	N	S	A	V	W	V	A	L	R	N	V	K	A	S	A	N	S	-	-	-	-	-	P	W	Q	H	C	I	D	R	Y	P	V	K	I	D	S	D	L	S	K		
✓ 13. KCS17_ARATH	R	G	D	R	T	W	Q	I	A	F	G	S	G	F	K	C	N	S	A	V	W	R	A	L	R	T	I	D	P	S	K	E	K	K	K	K	T	N	P	W	I	D	E	I	H	E	F	P	V	P	V	P	R	T	S	P	V		
✓ 14. KCS16_ARATH	K	G	D	R	I	W	Q	I	A	L	G	S	G	F	K	C	N	S	S	V	W	V	A	L	R	N	V	K	P	S	T	N	N	-	-	-	-	-	P	W	E	Q	C	L	H	K	Y	P	V	E	I	D	I	D	L	K	E		
✓ 15. KCS15_ARATH	R	G	D	R	V	W	Q	I	G	F	G	S	G	F	K	C	N	S	V	V	W	K	A	L	K	N	I	D	P	P	R	H	N	-	-	-	-	-	N	P	W	N	L	-	-	-	-	-	-	-	-	-	-	-	-	-			
✓ 16. KCS14_ARATH	R	G	D	R	V	W	Q	L	A	F	G	S	G	F	K	C	N	S	I	V	W	R	A	L	R	T	I	P	A	N	E	S	L	V	G	-	-	-	-	N	P	W	G	D	S	V	H	K	Y	P	V	H	V	T	-	-	-	-	
✓ 17. KCS13_ARATH	R	G	D	R	V	W	Q	L	A	F	G	S	G	F	K	C	N	S	I	V	W	R	A	L	R	T	I	P	A	N	E	S	L	V	G	-	-	-	-	N	P	W	G	D	S	V	H	K	Y	P	V	H	V	T	-	-	-	-	
✓ 18. KCS12_ARATH	R	G	D	R	V	F	M	I	S	F	G	A	G	F	K	C	N	S	C	V	W	E	V	V	R	D	L	T	G	G	E	S	K	G	N	-	-	-	-	-	V	W	N	H	C	I	D	D	Y	P	P	K	S	I	L	N	P	Y	L
✓ 19. KCS11_ARATH	K	G	D	R	I	W	Q	I	A	F	G	S	G	F	K	C	N	S	S	V	W	R	A	V	R	S	V	N	P	K	K	E	K	-	-	-	-	-	N	P	W	M	D	E	I	H	E	F	P	V	E	V	P	K	V	S	T	I	
✓ 20. KCS10_ARATH	R	G	D	R	V	W	Q	I	A	F	G	S	G	F	K	C	N	S	V	V	W	K	A	M	R	K	V	K	K	P	T	R	N	-	-	-	-	-	N	P	W	V	D	C	I	N	R	Y	P	V	P	L	-	-	-	-	-		
✓ 21. KCS1_ARATH	A	G	D	R	L	W	Q	I	A	F	G	S	G	F	K	C	N	S	A	V	W	K	A	L	R	P	V	S	T	-	E	E	M	T	G	-	-	-	-	N	A	W	A	G	S	I	D	Q	Y	P	V	K	V	V	Q	-	-	-	-

结果与讨论

- 推测这些高保守序列与此酶的功能相关
- 该酶存在两个跨膜区段分别位于16-33,54-71，则可推测该酶定位于膜上

致谢

- 感谢罗老师课堂上对我们学习的精心指导
- 感谢农科院及北大给我们提供的宝贵学习机会