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Marker assisted breeding in sugar beet: design and evaluation of molecular markers targeting early flowering

Houda KHAMIS

A dissertation in partial fulfillment of the requirements for the
degree of PhD in Biological Sciences

Supervisor: Pr. Pierre VAN CUTSEM

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By Houda Khamis

Beta vulgaris is a biennial plant, which under both vernalization and long photoperiods, shows early flowering during the first growing year. Early flowering of sugar beet results in a reduction of sugar yields. Despite systematic phenotypic counter-selection, early flowering plants are still observed in the fields.

The aim of this work was to identify sequence polymorphisms statistically associated with early flowering in sugar beet so they can be used to develop new molecular markers. These markers would contribute to improve breeding and selection for sugar beet varieties more resistant to early flowering.

To reach this goal, we followed a candidate gene approach relying on the extensive knowledge of flowering time control available on the model species *Arabidopsis thaliana*. In our strategy, we first isolated homologous genes related to flowering time control in sugar beet, we then studied their polymorphisms by performing EcoTILLING in contrasted samples originating from the same cultivar (Angeliqua). We finally looked for putative association between the identified genetic polymorphisms and the early flowering phenotype.

At the end of this research, we were able to identify SNP and indel polymorphisms in *BvGI*, *BvSUF4*, *BvPHYB*, *BvPHYA*, *BvFT1*, *BvCRY1*, *BvFY* and *BvTINYL2*. genes. Following the genotyping of two sets of contrasted sugar beet plants with PAMSA probes, statistically significant associations were confirmed between detected polymorphisms within *BvGI*, *BvSUF4*, *BvPHYB*, *BvTINYL2* genes and the early flowering phenotype.

In conclusion, the candidate gene approach proved to be a promising method to investigate phenotype / genotype association in sugar beet. Four promising targets were identified in this study. These results might favor the development of improved varieties of sugar beet.

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Table of contents

Table of contents	1
Abbreviations list.....	1
Aims of the work	3
Review of the literature	7
Part 1	9
Introduction of sugar beet.....	9
1 Brief history of sugar beet.....	10
2 Taxonomic Division of the Genus <i>Beta</i>	12
3 Economic Importance	12
4 The Biology of <i>Beta vulgaris</i> :	13
4.1 General Description	13
4.2 Breeding Objective:	15
5 Bolting and Early flowering in sugar beet (<i>Beta vulgaris</i>)	17
Part 2	22
Genetic control of flowering time	22
1 Introduction	22
2 The model plant <i>Arabidopsis thaliana</i> and its use in flowering time researches	23
2.1 Vernalization pathway	24
2.2 Photoperiod pathway.....	27
2.3 Autonomous pathway	33
2.4 Gibberellin pathway	35
2.5 Floral meristem identity genes.....	37
Part 3	39
Genetic polymorphism and identification of molecular markers	39
3 Introduction	39
4 Single Nucleotide Polymorphism (SNP)	40
5 Reverse Genetics and TILLING.....	41
5.1 TILLING	42
5.2 EcoTILLING: a natural polymorphism discovery tool	44
5.3 High Throughput SNP Genotyping	47
5.4 Allele specific hybridization.....	48
Primer Extension.....	49
Allele-specific oligonucleotide ligation:	50
Invasive cleavage	51

5.5	SNP genotyping by PAMSA	52
-----	-------------------------------	----

Chapter I

Isolation of putative flowering genes in sugar beet	55
---	----

1	Context and aims of chapter I	57
2	Candidate genes selection	59
3	Materials and methods	59
3.1	Bioinformatic analyses.....	61
3.2	Plant material and extraction of genomic DNA.....	61
3.3	Generation of PCR primers and PCR amplification	63
	Cycling conditions for the amplification of candidate genes	63
	PCR fragments excision and purification for cloning	63
3.4	Cloning of flowering genes homologs in sugar beet.....	63
	Bacterial strains and vectors.....	64
	Plasmid preparation	64
	Preparation of competent cells	65
	Protocol for preparing competent cells	66
	Heat shock transformation of <i>E. coli</i>	66
	Maxiprep QIAGEN Plasmid Maxi Kit (QIAGEN #12162).....	67
	Linearization of Plasmid.....	68
3.5	Plasmid and PCR products purification before cloning	68
3.6	Simultaneous restriction- ligation.....	69
3.7	Heat shock transformation of <i>E. coli</i>	69
3.8	Screening colonies of transformed <i>E. coli</i>	69
3.9	Miniprep	69
3.10	Sequence analysis	70
3.11	Sequencing reaction	71
	Sequencing reaction clean-up	71
3.12	Sequence homology analysis	71
4	Results	72
4.1	Selection of target flowering genes: bioinformatic approach.....	72
4.2	Cloning of putative <i>B. vulgaris</i> genes homologues to Arabidopsis vernalization pathway genes	74
4.3	Cloning of putative <i>B. Vulgaris</i> homologs to Arabidopsis photoperiod pathway	79
4.4	Cloning of putative orthologs of flowering genes involved in the autonomous pathway in sugar beet:	84
5	Discussion	87
6	Conclusion.....	91

Chapter II

Investigating the genetic bases of flowering time variability in <i>B. vulgaris</i> ...	93
---	----

1	Context and aims of chapter II	95
2	Introduction.....	95
3	SNP detection by EcoTILLING.....	96
4	Materials and methods	98
4.1	Plant material and genomic DNA extraction.....	98

4.2	Target selection	104
4.3	Primers design.....	104
4.4	Scanning for SNP polymorphisms in candidate genes by EcoTILLING	107
4.5	Statistical evaluation of SNPs.....	107
4.6	Sequencing	108
5	Results	108
5.1	SNP identification in the sugar beet flowering related genes by EcoTILLING	108
5.2	Sequencing results	111
5.3	Screening for polymorphisms associated with early flowering in the candidate genes of sugar beet	112
	EcoTILLING and sequencing results in BvCRY1 gene	112
	EcoTILLING and sequencing results in BvFT1 gene:	114
	EcoTILLING and sequencing results in BvFY	115
	EcoTILLING and sequencing results in BvGI	115
	EcoTILLING and sequencing results in BvPHYB	115
	EcoTILLING and sequencing results in BvPHYA	115
	EcoTILLING and sequencing results in BvTINYL2.....	116
	EcoTILLING and sequencing results in SUF4.....	116
	EcoTILLING and sequencing results in BvVIL2	116
	EcoTILLING and sequencing results in BvLDL1	117
6	Discussion	119
17.1	High polymorphism in sugar beet flowering genes highlighted by EcoTILLING	119
7	Conclusions.....	121

Chapter III

Genotype-phenotype association of putative flowering gene polymorphisms and flowering time variations in <i>B. vulgaris</i>	123
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1	Context and aims of chapter III	125
2	Introduction.....	126
3	Materials and methods	127
3.1	Plant material and genomic DNA extraction.....	127
3.2	Primers Design and cycling conditions.....	128
3.3	Statistical analysis	128
4	Results	131
4.1	Association of BvSUF4 polymorphism with flowering time	133
4.2	Association of BvGI polymorphism with flowering time	134
4.3	Association of BvPHYB polymorphism with flowering time.....	134
4.4	Association of BvTINYL2 polymorphism with flowering time ...	135
4.5	Association of BvPHYA polymorphism with flowering time.....	135
4.6	No association of BvFT1 polymorphism with flowering time	136
4.7	No association of BvFY polymorphism with flowering time.....	136
4.8	No association of BvCRY1 polymorphism with flowering time.	137
5	Discussion	140
6	Conclusion.....	142

Final conclusions and prospects..... 145

Cited literature 155

References 157