Detection Methods for GM Foods in Korea

Hae-Yeong Kim

Graduate School of Biotechnology

Kyung Hee University

Kim, Hae-Yeong, Ph.D.

1.Professor in Department of Food Sciences,
Kyung Hee University, Korea (1996 – present)

2. Committee member of GMO safety assessment in Food
of KFDA (2001 – present)

3. Committee member of GMO safety assessment in Feed
of RDA (2003 – present)

4. Research Project Leader in GMO detection
- Multiplex PCR ,Microarray, nano-technique

Background of GMO management in Korea

1. **Increasing the mount of GMO development in the world**

   - Global status of GMO Approval : 196 events in 24 crops (ISAAA, 2011)

2. **Could not escape from GMO**

   - very low self-supply of crops in Korea (below 30%)

   - Soybean ~5%, corn ~3%

3. **Changes of consumer's awareness on Food safety**

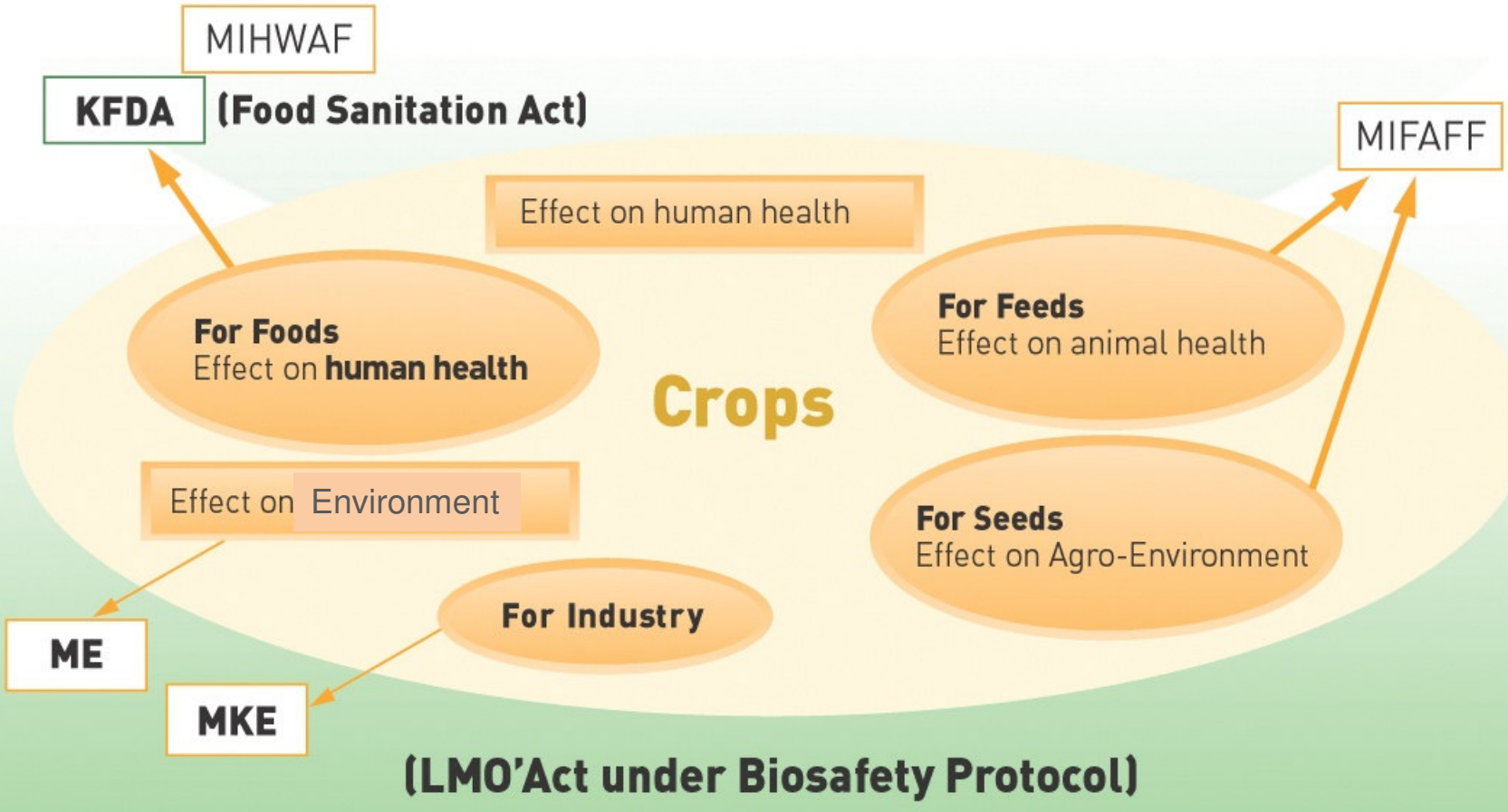
   - increase the claim of food safety by NGOs against GMO

   - Increase the need of well-being and organic foods

4. **Manage to Unapproved GMO**

   - GM rice, GM papaya, GM flax , GM maize

Authorities for LMO/GMO Management



GM crops approved as Food by KFDA (76 events)

Crops	GM Events
Soybean (8)	RRS, A2704-12, MON89788, DP356043-5, DP305423-1, A5547-127, MON87701, DP305423-1xRRS
Maize (41)	MON810, TC1507, GA21, NK603, Bt11, T25, MON863, Bt176, DLL25, DBT418, DAS-59122-7, MON88017, Bt10, MIR604, MON89034, DP-098140-6, MIR162, 3272, MON863×NK603, MON863×MON810, MON810×NK603, MON810×GA21, 1507×NK603, MON810×MON863×NK603, DAS-59122-7×1507×NK603, 1507×DAS-59122-7, DAS-59122-7×NK603, Bt11×GA21, MON88017×MON810, Bt11×MIR604, Bt11×MIR604×GA21, MIR604×GA21, MON89034×MON88017, MON89034×NK603, MON89034×TC1507×MON88017×DAS-59122-7, 1507×DAS-59122-7×MON810×NK603, 1507×MON810×NK603 , NK603×T25, MON89034×TC1507×NK603, Bt11×MIR162×MIR604×GA21, 1507×MIR604×NK603,
Cotton (15)	531, 757, 1445, 15985, 281/3006, LLcotton25, MON88913, GHB614,15985×1445, 531×1445, 15985×LLcotton25, MON15985×MON88913 281/3006×88913, 281/3006×1445, GHB614×LLcotton25
Canola (6)	GT73, Ms8/Rf3, T45, Ms1/Rf1, Ms1/Rf2, Topas 19/2
Potato (4)	SPBT02-05, RBBT06, Newleaf Y, Newleaf PLUS
Sugar beet (1)	H7-1
Alfalfa (1)	J101/J163

(KFDA, 2012.4.)

Needs of GMO Detection method in Korea

For Approved GM food Labeling Systems

(Article 10 in Korean Food Sanitation Act)

- "Non GMO / Organic products / Korean products"
  → Detect the existence of GMO (Qualitative)
- "Labeling-free products"
  → Ascertain the Adventitious presence threshold level (≤ 3%) for authorized GMO
  (IP Handling Certificates, Government Certificates, Quantitative)

For Mandatory Safety Assessment

(Article 4.6 in Korean Food Sanitation Act)

- Inspection of unapproved GMO (Qualitative)
- Prevent the import and distribution of unapproved GMO

For Risk Communication

- Post-market monitoring
- Right-to-Know for consumers

Multiplex PCR

- A simultaneous detection of various GMO in a single reaction, without loss of specificity
  - Different events of GMO : soybean, maize, cotton, canola

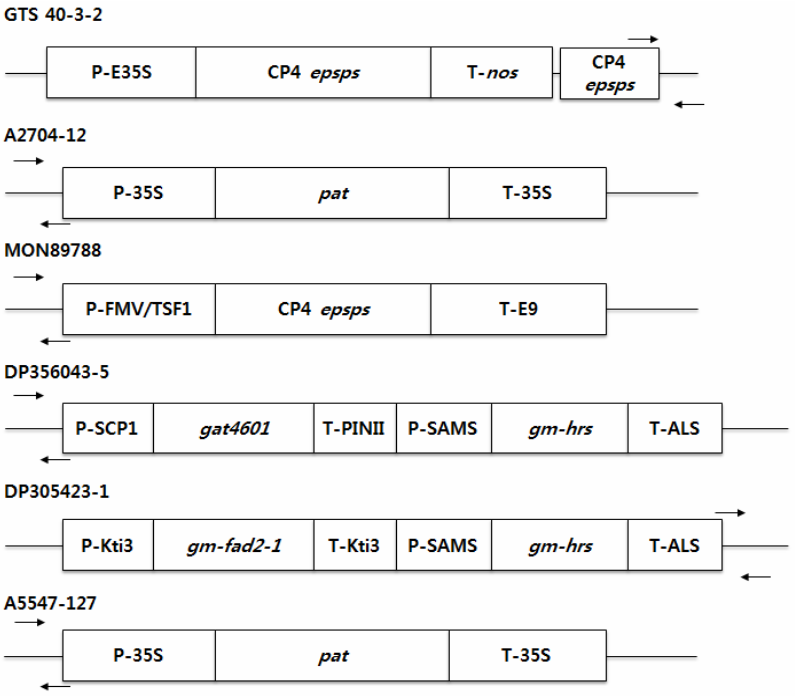
Microarray

- An event-specific DNA microarray to identified GMO in Food

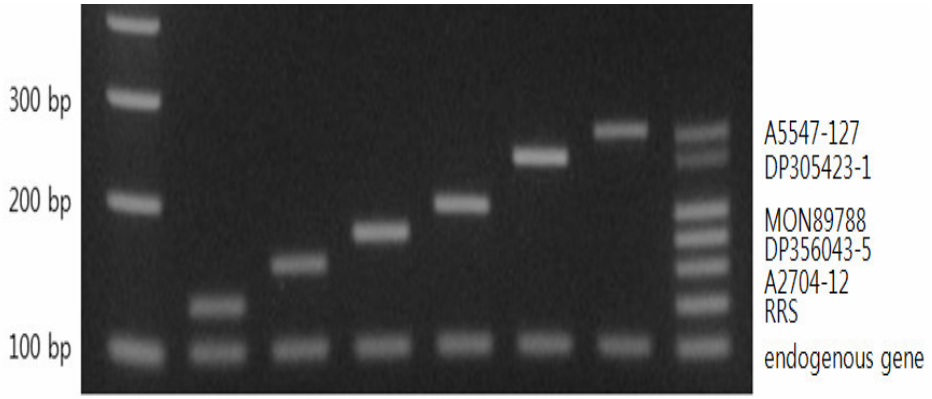
KFDA 식품의약품안전청 Korea Food & Drug Administration

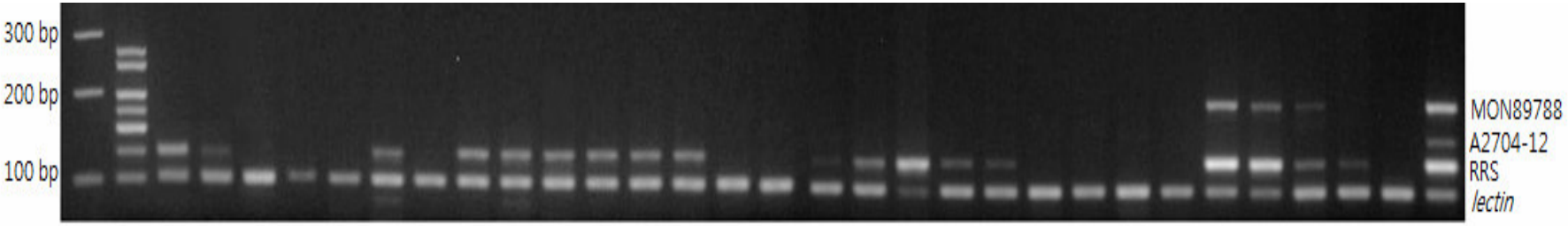
RDA 농촌진흥청

Development of a Multiplex PCR Method for Testing 6 GM Soybean Events



A multiplex PCR assay consisting of six event-specific fragments and one *lectin* fragment was optimized and developed





(Kim *et al,* 2012 submitted)

Detection of 8 events of GM Maize by Multiplex PCR

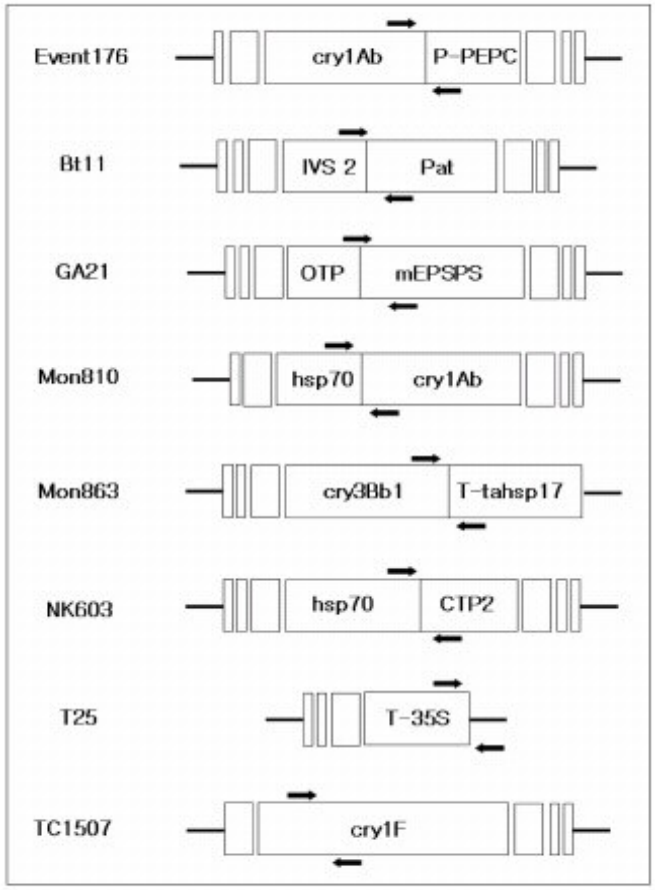


Fig. 1. Schematic diagram of eight events of GM maize.

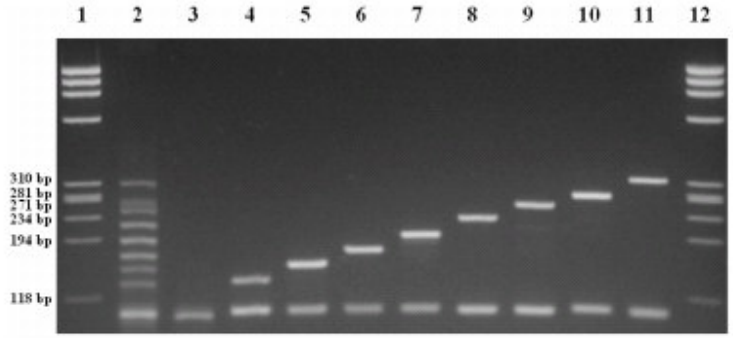


Fig. 2. Multiplex PCR products amplified from 100% GM maize containing zein gene (endogenous gene). Lane 1 and 12: Marker; ØX174 DNA/HaeIII(TaKaRa, Japan), lane 2: Zein (endogenous gene, 99 bp), GA21(133 bp), T25(152 bp), TC1507 (172 bp), Mon810(193 bp), Mon863(223 bp), Event176(248 bp), Bt11 (265 bp) and NK603(314 bp), lane 3: Zein, lane 4: Zein and GA21, lane 5: Zein and T25, lane 6: Zein and TC1507, lane 7: Zein and Mon810, lane 8: Zein and Mon863, lane 9: Zein and Event176, lane 10: Zein and Bt11, lane 11: Zein and NK603.

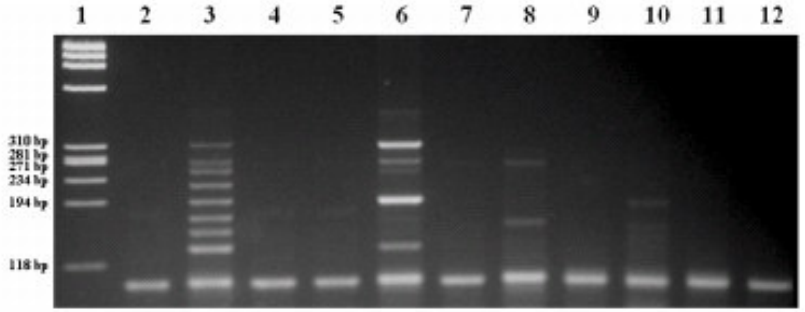


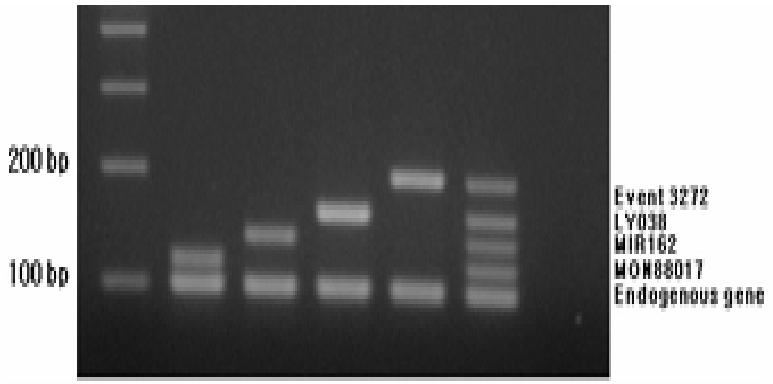
Fig. 3. Multiplex PCR products amplified from various maize foods. Lane 1: Marker; ØX174 DNA/*Hae*III(TaKaRa, Japan), lane 2: Negative control, lane 3: Positive control, lane 4: Corn grits, lane 5: Cooking oil from corn, lane 6: Corn for feeding, lane 7: Canned corn, lane 8: Mixed vegetables, lane 9: Corn soup, lane 10: Corn chip, lane 11: Popcorn, lane 12: Cereal.

Food Sci. Biotechnol. 15, 148 (2006)

Multiplex PCR Detection of Four events of GM maize (Event3272, LY038, MIR162, and MON88017)

An event-specific multiplex PCR detection method for four events of GM maize was devised.

- Event 3272 : thermostable alpha amylase (amy797E) / mannose-6-phosphate isomerase (pmi)
- LY038 : dihydrodipicolinate synthase (cordapA)
- MIR162 : vegetative insecticidal protein (vip3A)
- MON88017 : delta-endotoxin (cry3Bb1) /cp4 epsps



Kim et al, (2009) *J. Korean Soc. Appl. Biol. Chem*. 52, 105

Multiplex PCR Detection of the MON1445, MON15985, MON88913, and LLcotton25 Varieties of GM Cotton

Event specific primers were used to distinguished 4 different GM cottons.

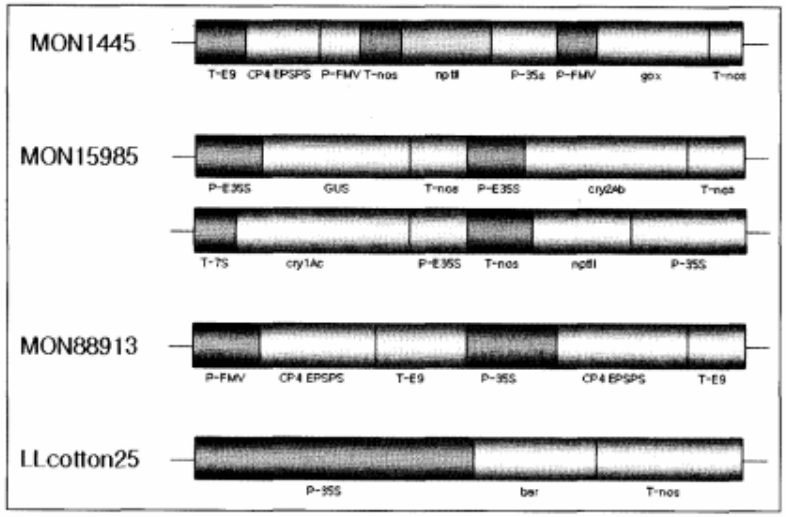
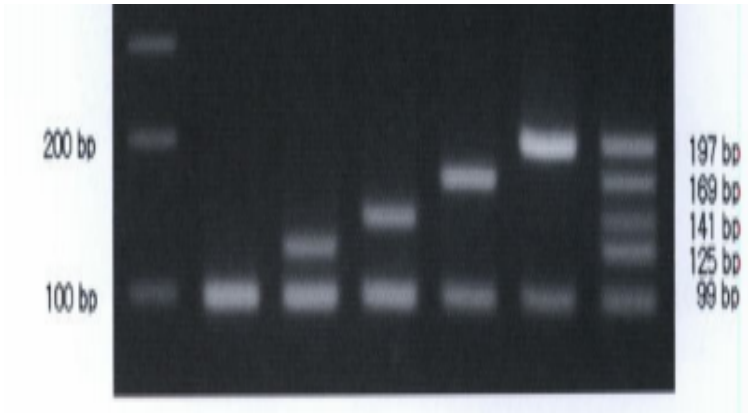


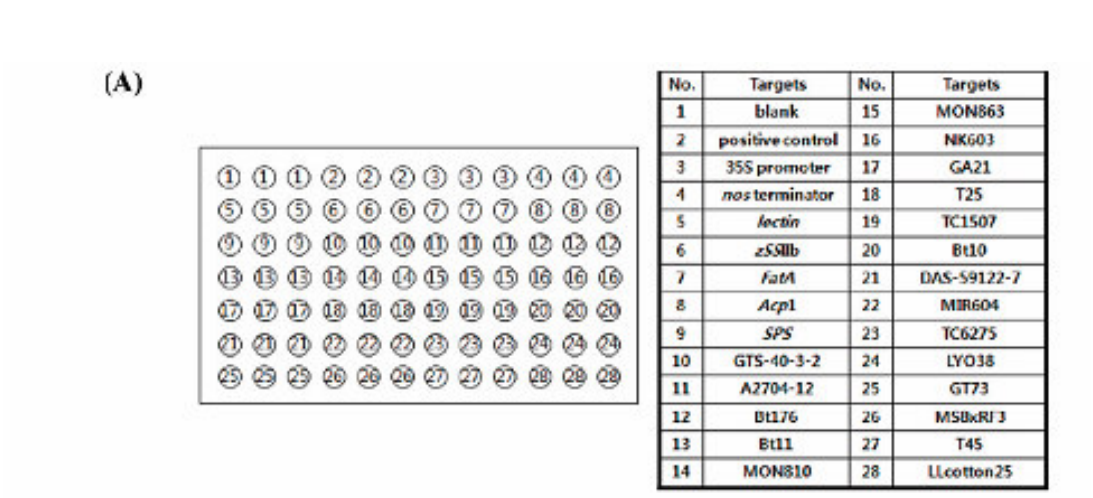
Fig. 1. Schematic diagram of 4 varieties of GM cotton.



Kim *et al.,* (2008) *Food Sci. Biotechnol*. 17, 829

An event-specific DNA microarray to identify genetically modified organisms (GMOs) in processed foods.

We developed an event-specific DNA microarray system to identify 19 GMOs, including two GM soybeans (GTS-40-3-2 and A2704-12), thirteen GM maizes (Bt176, Bt11, MON810, MON863, NK603, GA21, T25, TC1507, Bt10, DAS59122-7, TC6275, MIR604, and LY038), three GM canolas (GT73, MS8□RF3, and T45), and one GM cotton (LLcotton25).



No.	Targets	No.	Targets
1	blank	15	MON863
2	positive control	16	NK603
3	35S promoter	17	GA21
4	*nos* terminator	18	T25
5	*lectin*	19	TC1507
6	*zSSIIb*	20	Bt10
7	*fatA*	21	DAS-59122-7
8	*Acp1*	22	MIR604
9	*SPS*	23	TC6275
10	GTS-40-3-2	24	LY038
11	A2704-12	25	GT73
12	Bt176	26	MS8xRF3
13	Bt11	27	T45
14	MON810	28	LLcotton25

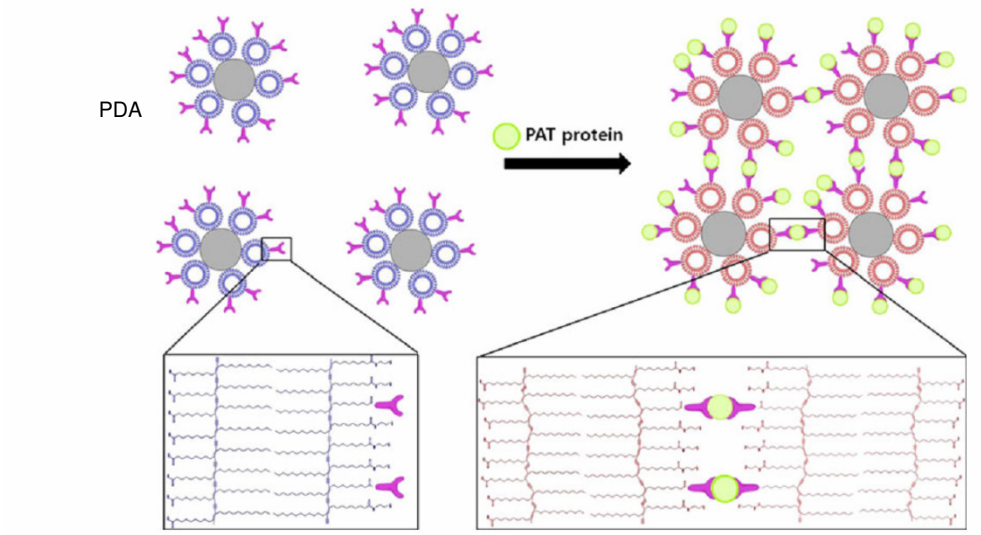
Kim *et al.,* (2010) *J. Agric. Food Chem.* 58, 6018

Microarray Detection of GM Maize in Processed Foods

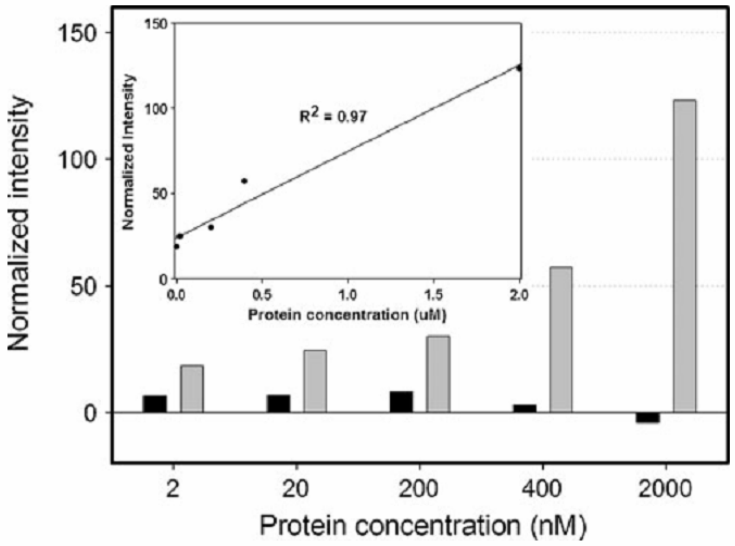
		GM maize events													
sample no.	type of product	Bt176	Bt11	MON810	MON863	NK603	GA21	T25	TC1507	Bt10	DAS-59122-7	MIR604	TC6275	LY038	no. of GM maize
1	nacho chips A	−	−	−	−	−	−	−	−	−	−	−	−	−	0
2	nacho chips B	−	−	−	−	−	−	−	−	−	−	−	−	−	0
3	nacho chips C	−	−	+	−	+	−	−	−	−	+	−	−	−	3
4	nacho chips D	−	−	−	−	−	−	−	−	−	−	−	−	−	0
5	nacho chips E	−	−	−	−	−	−	−	−	−	−	−	−	−	0
6	nacho chips F	−	−	+	−	+	−	−	+	−	+	−	−	−	4
7	nacho chips G	−	−	−	−	−	−	−	−	−	−	−	−	−	0
8	corn chips	−	−	−	−	−	−	−	−	−	−	−	−	−	0
9	corn soup A	−	−	+	−	+	−	−	−	−	−	−	−	−	2
10	corn soup B	−	−	−	−	−	−	−	−	−	−	−	−	−	0
11	corn soup C	−	−	−	−	−	−	−	−	−	−	−	−	−	0
12	corn soup D	−	−	+	−	+	+	−	+	−	+	−	−	−	5
13	corn soup E	−	−	−	−	−	−	−	−	−	−	−	−	−	0
14	corn soup F	−	−	−	−	−	−	−	−	−	−	−	−	−	0
15	canned corn soup	−	−	−	−	−	−	−	−	−	−	−	−	−	0
16	canned sweet corn A	−	−	−	−	−	−	−	−	−	−	−	−	−	0
17	canned sweet corn B	−	−	−	−	−	−	−	−	−	−	−	−	−	0
18	canned sweet corn C	−	−	−	−	−	−	−	−	−	−	−	−	−	0
19	canned sweet corn D	−	−	−	−	−	−	−	−	−	−	−	−	−	0
20	popcorn A	−	−	−	−	−	−	−	−	−	−	−	−	−	0
21	popcorn B	−	−	−	−	−	−	−	−	−	−	−	−	−	0
22	popcorn C	−	−	−	−	−	−	−	−	−	−	−	−	−	0
23	corn flour A	−	−	−	−	+	−	−	−	−	−	−	−	−	1
24	corn flour B	−	−	+	−	−	−	−	−	−	−	−	−	−	1
25	corn flour C	−	−	−	−	−	−	−	−	−	−	−	−	−	0
26	corn flour D	−	+	+	+	+	+	+	+	−	+	+	−	−	9
27	corn flour E	−	−	−	−	−	−	−	−	−	−	−	−	−	0
28	corn bread A	−	−	−	−	−	−	−	−	−	−	−	−	−	0
29	corn bread B	−	−	−	−	−	−	−	−	−	−	−	−	−	0
30	corn bread C	−	−	−	−	−	−	−	−	−	−	−	−	−	0
31	corn bread mix A	−	−	−	−	−	−	−	−	−	−	−	−	−	0
32	corn bread mix B	−	−	−	−	−	−	−	−	−	−	−	−	−	0
33	corn bread mix C	−	−	+	−	+	−	−	+	−	+	−	−	−	4
34	corn bread mix D	−	+	+	−	+	+	+	+	−	+	−	−	−	7
35	corn starch A	−	−	+	−	−	−	−	−	−	−	−	−	−	1
36	corn starch B	−	−	+	−	+	−	−	+	−	−	−	−	−	3
37	sausage containing corn	−	−	−	−	−	−	−	−	−	−	−	−	−	0

Microbead-assisted PDA sensor for the detection of genetically modified organisms

A simple and sensitive approach for the detection of marker protein, phosphinothricin acetyltransferase (PAT), from GM crops was developed based on the colorimetric transition of polydiacetylene (PDA) vesicles in combination with silica microbeads



Scheme 1 Schematic illustration of colorimetric detection for PAT protein by PDA vesicle–silica bead conjugate biosensor



Lim *et al.,* (2011) *Anal. Bioanal. Chem.* 400, 777

Unauthorized GMOs in Korea

- GMOs that are approved in other countries but not in Korea or that have not been approved elsewhere in the world.

- The Korea threshold for Unauthorized GMOs is zero, which means that their presence is not allowed in food or feed.

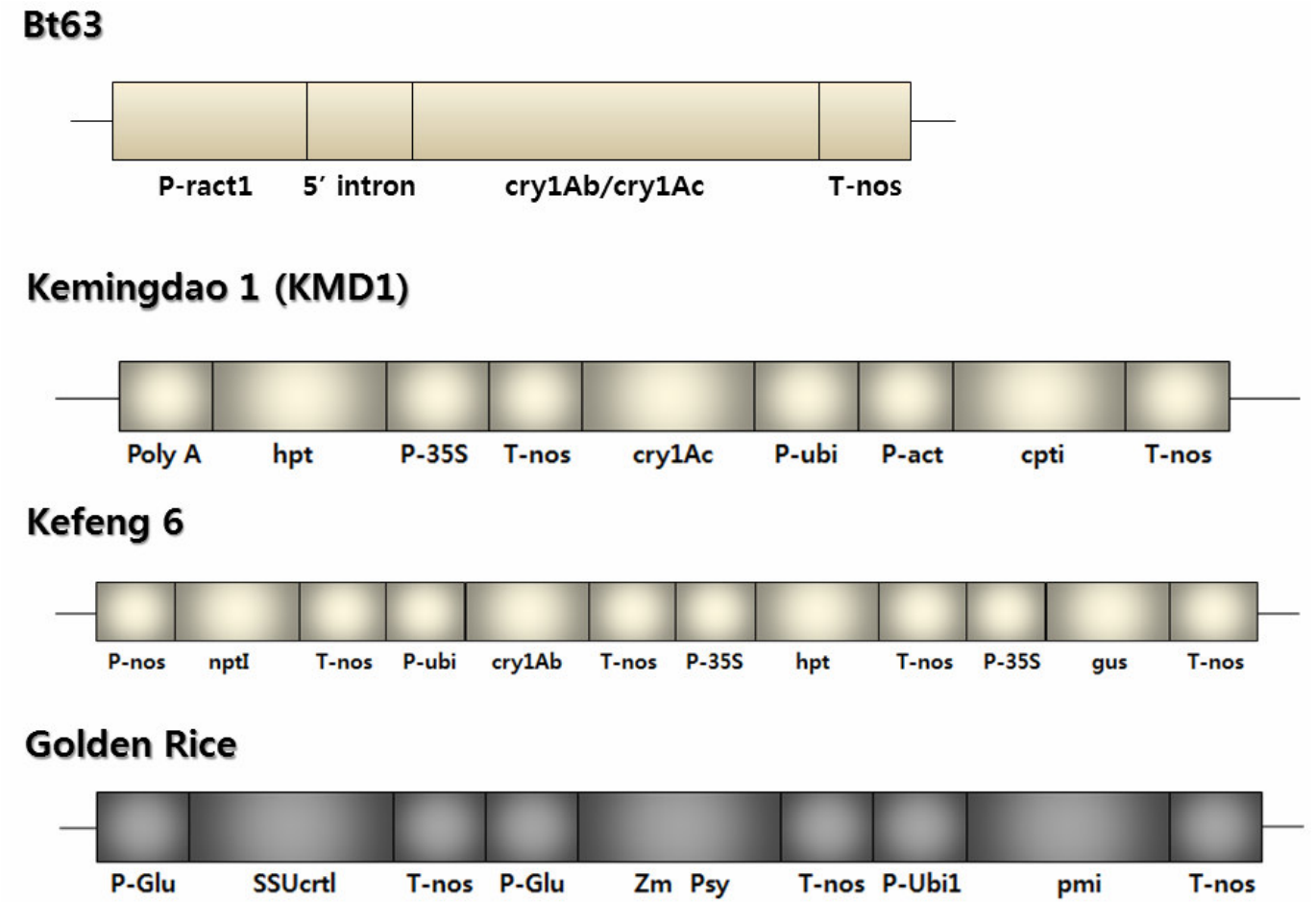
- ✓ **Flax**
- ✓ **Rice**
- ✓ **Papaya**
- ✓ **Tomato**

- ✓ **Carnation**
- ✓ **Rose**

KFDA 식품의약품안전청

국립식물검역원
National Plant Quarantine Service

Simultaneous Detection of Unapproved GM Rice using Event-specific Primers



Conclusion

- Development of Detection methods
  - Multiple GM crops in Food
  - Unauthorized GMO
  - Stacked GMO
  - New approaches : Nanobiotechnology

- International Collaboration
  - Genetic Information: database
  - Standard materials
  - Interlaboratory test

Seoul Campus

Yongin Campus

Kyung Hee University