A TRIZ-Based Solution to Problems in Red Ginseng Processing

Moo Woong Kim

Biotech Policy Research Center, KRIBB, moongkim@kribb.re.kr

Eun Jung Kim (Biotech Policy Research Center, KRIBB, ejtkd50@gmail.com)

Min Jung Kim (Biotech Policy Research Center, KRIBB, bestkmj@kribb.re.kr)

Ju Sik Kam (Project Office of S&T, University of Science and Technology, jskam@ust.ac.kr)

Kyu Il Kim (Institute of Jinan Red Ginseng, redgin7@naver.com)

Sang Min Jang (Institute of Jinan Red Ginseng, handin@ijrg.re.kr)

Hye Young Lee (Institute of Jinan Red Ginseng, hylee@ijrg.re.kr)

Byung-Hwan Hyun ((Biotech Policy Research Center, KRIBB, bhhyun@kribb.re.kr)

Contents

- Purpose of Research
- Pursuance Method and Range of Research
- Research Results
  - (1) Deducing Solutions using TRIZ
  - (2) Test Results on TRIZ Solutions
- Summary and Conclusion

1. Pursuance Background and Objective

- As creativity and innovation became important keywords for success, there has been rising interest in TRIZ (Theory of inventive problem solving)

  - TRIZ is a creative problem-solving technique created by Genrich Altshuller of Russia. It analyzes over 2 million patents and categorized problem solving thought processes in the process of inventing into forty groups. It has been implemented in the electronics and mechanical sectors and is the driving force behind product innovation

  - Companies such as POSCO, Samsung and Hynix, as well as universities utilize TRIZ. However, there were no cases in which TRIZ was used in the bio sector for innovative research and technological development.

- Thus, this study implements TRIZ in the problem (bottleneck) faced in pursuing R&D for the bio sector, which is a promising future sector, to examine whether it can potentially have positive effects on resulting in innovative research and technological development.

  - This study aims to apply TRIZ in the bio sector research research and technological development to resolve problems and to conduct case studies on whether creative and innovative can be made possible through this

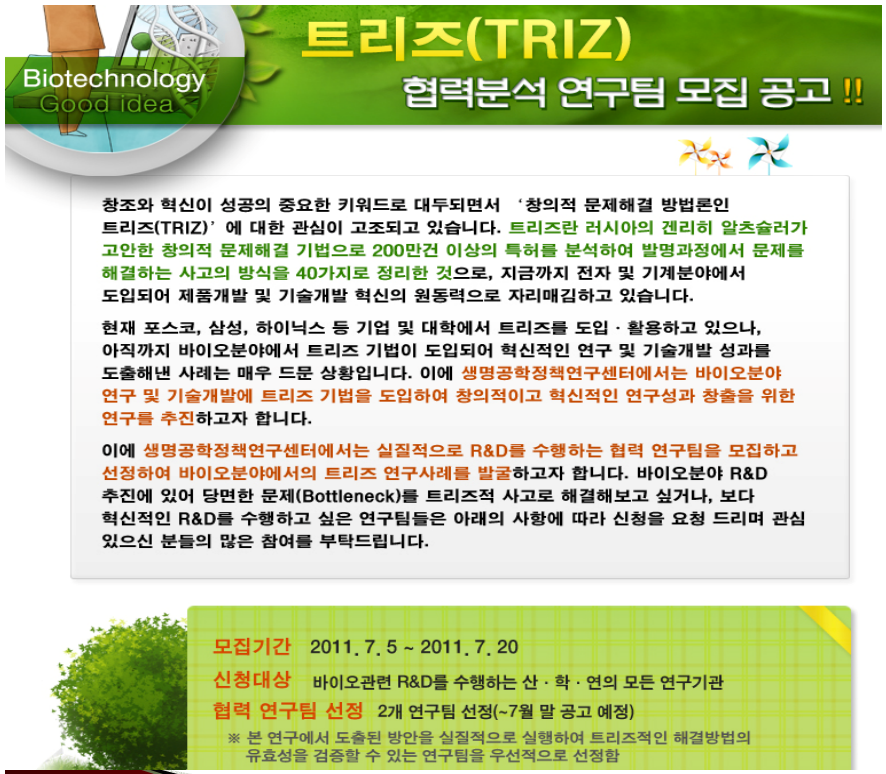
"Creativity can be learned"
Genrich Altshuller(1926~1998)

2. Pursuance Method and Range of Research (1)

TRIZ Analysis Cooperative Research Team Recruited Online (Jul 2011)

- Hold interviews to discuss research theme and method for selection

※ Research teams that can verify the effectiveness of TRIZ solutions through R&D and who can assertively participate in coming up with TRZI solutions will be given priority in selection



TRIZ Cooperative Analysis Research Team Recruitment Ad!!
As creativity and innovation became important keywords for success, there has been rising interest in TRIZ (Theory of inventive problem solving). TRIZ is a creative problem-solving technique created by Genrich Altshuller of Russia. It analyzes over 2 million patents and categorized problem solving thought processes in the process of inventing into forty groups. It has been implemented in the electronics and mechanical sectors and is the driving force behind product innovation.
Companies such as POSCO, Samsung and Hynix, as well as universities utilize TRIZ. However, there were no cases in which TRIZ was used in the bio sector for innovative research and technological development. Thus, the Biotech Policy Research Center plans to achieve creative and innovative research accomplishments by implementing TRIZ in bio research and technology development through research for creative an innovating research performance. Accordingly, the Biotechnology Policy Research Center aims at finding TRIZ research cases in the bio sector by recruiting cooperative research teams that will carry out the actual R&D. We invite research teams who want to attempt solving the problem (bottleneck) in pursuing bio R&D or that want to carry out innovative R&D. Please apply according to the below.

Application Period: Jul 5, 2011 – Jul 20, 2011
Target Applicants: All industry, academic and research institutes that conduct R&D on bio
Selection of Cooperative Research Team: 2 research teams to be selected (announced at the end of July)
*** Research teams that can execute methods deduced from this research and verify the effectiveness of TRIZ solutions will be given preferential treatment in selection.**

Selection: Standardization of Red Ginseng Processing (Institute of Jinan Red Ginseng)

2. Pursuance Method and Range of Research (2)

General Information on Red Ginseng

- Ginseng is a perennial herb in the ginseng family and its root is named ginseng radix and used for medicinal purposes. Red ginseng is made by steaming ginseng and the method for processing it by steaming and then drying was available since before the Goryeo Dynasty

- According to the Ginseng Industry Act, red ginseng is 'made by steaming and aging fresh ginseng by steaming or other methods' and are those with color as designated by the Ministry for Food, Agriculture, Forestry and Fisheries.

– In 1895 (reign of Gojong) the Ginseng Act was declared and in 1908 it was designated by law that only the government could produce red ginseng. However, this was abolished in 1996 and anybody with prescribed facilities can not process and sell red ginseng

– Ginseng was processed into red ginseng initially to be able to store it longer, but later it was discovered that the biochemical changes are highly beneficial for people. Important ingredients that are changed during red ginseng processing include saponin and non-saponin polyacetylene, acidic polysaccharide, and amino acids

< Table. Red Ginseng Processing Sequence >

Red Ginseng Processing Sequence	Note
1. Collecting & categorizing fresh ginseng	By size (XXL, XL, L, M, S)
2. Fresh ginseng cleaning	Cylindrical cleaner
3. Categorization by fresh ginseng rating	By shape (heaven, earth, good, cut, other)
4. Steaming	Use steam or heat conductor
5. 1st Drying	Natural or forced drying

Red Ginseng Processing Sequence	Note
6. 1st Chimi	Cutting and arranging main roots and fine roots
7. Trimming, 2nd Chimi, Moistening, Pressing, 2nd Drying	Shaping, pressing to fit can packaging, adjust moisture to under 15%
8. Inspection and grade categorization	NH Agricultural Cooperative Ginseng Inspection Center
9. Packaging and Shipping	

2. Pursuance Method and Range of Research (3)

Problems in Red Ginseng Processing

- When steaming, heat sources such as high temperature steam are used to process the ginseng depending on its size for 2 to 4 hours at 90 to 100℃, during this process, the ginseng's body cracks

⇒ The larger the ginseng and thicker its crust, the higher temperature has to be, and when higher, more cracking occurs

⇒ When the ginseng cracks, it not only lowers the quality of appearance, but also high loss of effective ingredients such as saponin occurs

※ According to tests by the lab, there is over 30% loss on average

– When the temperature is lower during steaming, it becomes discolored and does not change into active ingredients sufficiently

⇒ When the temperature is low during steaming, the steaming period becomes longer, causing longer processing times, and resulting in not being able to process all ginseng collected during September to November

⇒ Also, when having to store at low temperatures and process later, the quality draws and causes storage costs, or cannot be processed into red ginseng, resulting in problems such as having to be distributed as raw ginseng.

◆ Problems to be Solved with TRIZ ◆

Search for measures to prevent or reduce cracking of ginseng when steaming at high temperatures for processing red ginseng

3. Deducing Solutions using TRIZ (1)

Definition of Problem

- While steaming fresh ginseng for red ginseng processing, it sometimes cracks

Analysis of Cause of Problem

- Temperature must be high when steaming for efficient red ginseng processing, but the temperature must be low to prevent cracking of the ginseng

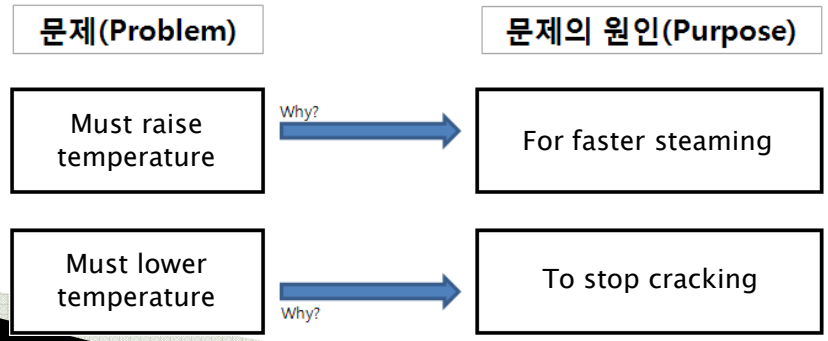
① Must steam fresh ginseng using steam for red ginseng processing

② For efficient (reduced time) steaming, it must be at high temperatures (95℃ or higher)

③ There must be no cracks for processing high quality red ginseng

④ Cracking of fresh ginseng occurs due to high temperatures

< Figure. Deducing Problem and its Cause >



3. Deducing Solutions using TRIZ (2)

Deducing Contradictions

- Categorize as problem and cause of problem using PTC modeling to deduce contradictions in the red ginseng processing procedure.

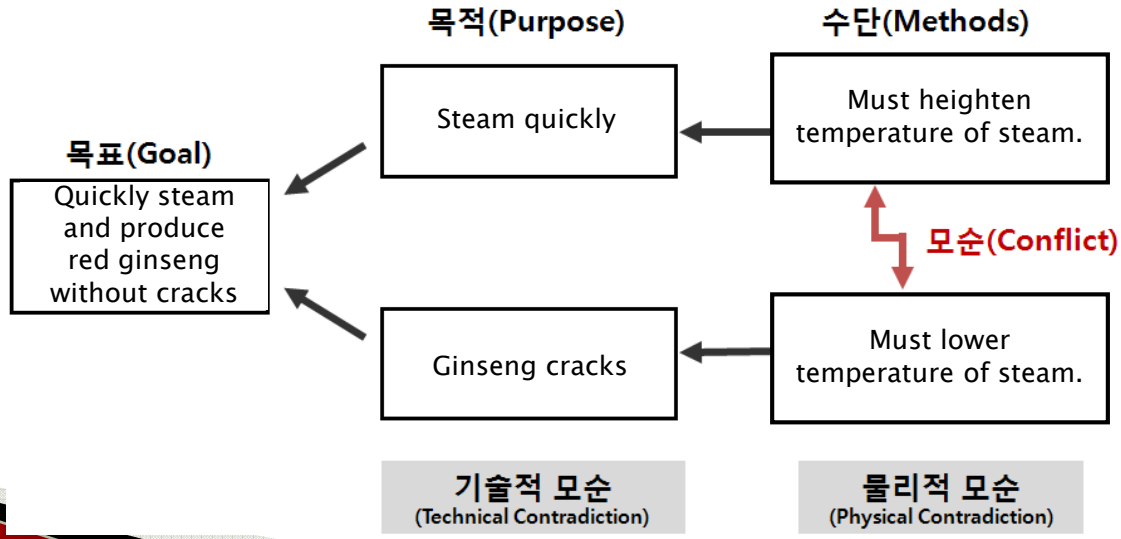
In TRIZ, contradictions are categorized as physical contradictions (one variable having to have different values simultaneously) and technical contradiction (mutual exclusive relationship of different properties)

※ PTC(Physical Technical Contradiction) Modeling

⇒ Physical Contradiction (Method): Temperature for steaming must be high and low

⇒ Technical Contradiction (Purpose): For steaming and to prevent cracking

< Figure. Deducing Contradictions >



3. Deducing Solutions using TRIZ (3)

Deducing IFR (Ideal Final Result)

- This research aims at analyzing methods that can resolve technical contradictions among contradictions that occur during red ginseng processing.

Deduce IFR by cross-checking problem and cause of problem

① IFR: Method for quickly steaming at low temperatures

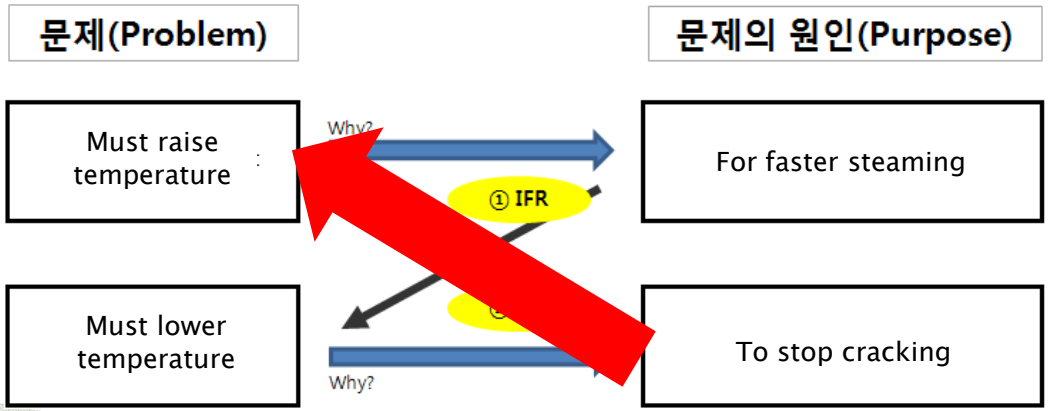
② IFR: Method for preventing cracks at high temperatures

※ The IFR is a solution with infinite idealness and idealness is the cost to effect. TRIZ is not a methodology for general improvements, but a methodology for achieving innovation that overcomes contradictions to attain max effects with minimal expenses

⇒ Separation principle (time, space, all and part) applied for physical contradictions

⇒ Can deduce IFR that overcomes contradictions by applying 40 invention principles for technical contradictions

< Figure. Deducing IFR >



3. Deducing Solutions using TRIZ (4)

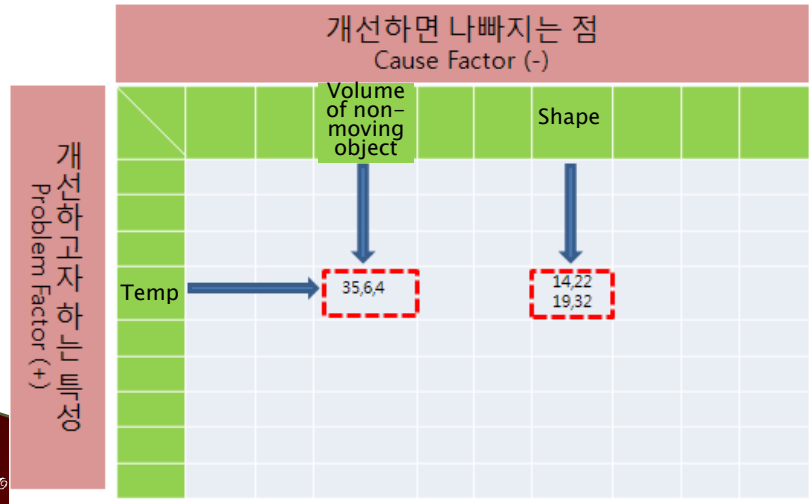
Suggesting IFR through 40 Invention Principles

① Using Contradiction Matrix

- The contradiction matrix is composed vertically and horizontally by making the technical variables into 39 patterns. The problem factor for the problem to be solved is put in the vertical axis and the cause factor is placed in the horizontal to make it possible to identify the number of the invention principle according to the vertical and horizontal axes.

- By reading each of the 2 million cases and analyzing patterns to discover the general common and differences of problem-solving for contradiction tables that overcome technical difficulties, it offers problem-solving tools

< Figure. Using Contradiction Matrix >



▶ When 17. temperature is selected for useful parameter and volume of non-moving object 8. is selected for harmful parameter

- Invention principle 35 **Property change**
- Invention principle 6 **One for many uses**
- Invention principle 4 **If symmetric, to asymmetric**

▶ When 17. temperature is selected for useful parameter and 12. shape is selected for harmful parameter

- Invention principle 14 **Straight line to curve**
- Invention principle 22 **Bad to good**
- Invention principle 19 **Regularly operate**
- Invention principle 32 **Color change**

3. Deducing Solutions using TRIZ (5)

Suggesting IFR through 40 Invention Principles

② Brainstorming

- In order to solve deduced problems and causes of problems, apply 40 invention principles through brainstorming and deduce applicable invention principles

No	Section	Applicable Idea
1	Invention Principle 1 Separation	Steam, check and then steam again
2	Invention Principle 7 Stacking	Stack diagonally to steam
3	Invention Principle 9 Preceding Drag	Soak in water first and then steam
4	Invention Principle 10 Early Measures	Cut fresh ginseng to prevent cracking. Or, treat X that can prevent cracking of fresh ginseng in advance
5	Invention Principle 12 Equivalence	Hang red ginseng in air
6	Invention Principle 13 Thinking Outside of the Box	Does it have to be steamed? Think about other methods than steaming
7	Invention Principle 17 Dimension Change	Change steam direction (rather than using only from the bottom, steam from side), Install fan (randomize steam direction)
8	Invention Principle 18 Use Vibration	Give vibration on floor of steamer to prevent cracking
9	Invention Principle 19 Regular Effects	When steaming fresh ginseng, rather than heating at consistent temperature, pause when cracking occurs
10	Invention Principle 21 Acceleration	Add pressure and steam for short period with high temperature
11	Invention Principle 24 Mediated Material	Wrap oil pipe with mediated material
12	Invention Principle 30 Thin Cover	Steam by coating with starch paste
13	Invention Principle 31 Porous Material	Punch red ginseng to prevent cracking
14	Invention Principle 35 Property Change	Add X to material, heighten boiling point to steam in short period
15	Invention Principle 38 Forced Activator	Add X that enhances efficiency while steaming to shorten steaming period

3. Deducing Solutions using TRIZ (6)

Suggesting IFR through 40 Invention Principles

③ Examination of Preceding Literature and 2nd Brainstorming

- Based on 1st test results, examine preceding patent documents and conduct secondary brainstorming to deduce more efficient method. Examine preceding patents focusing on Korean, Chinese and US patents through Focust of Wisdomain

No	Section	Applicable Ideas
1	Invention Principle 9 Preceding Drag	Foods containing starch, which is in red ginseng, undergoes fat break down enzymes in ingredients to improve handling of paste, texture and appearance. Accordingly, fat break down enzyme attempted on surface of fresh ginseng or inside steamer
2	Invention Principle 10 Take Measures in Advance	Cover ginseng with wrapping so that it is not directly heated while steaming. Expected that heat and nutrients will not be lost easily compared to when steaming as practiced. Also, steam by placing in box (wooden or metal box) so that the steam or heat does not come into direct contact, but exposed indirectly
3	Invention Principle 11 Preceding Measures	Ginseng cracks due to increase of internal pressure. Allow depressurization by making cuts in the ginseng or pre-processing at medium temperatures before high-temperature steaming
4	Invention Principle 16 Excess or Lacking	Starch, which is in red ginseng, tends to absorb moisture and become larger, so reduce amount of steam and find moisture level that minimizes expansion of starch
5	Invention Principle 19 Regular Effects	10 minutes at 40 degrees, 2 hours at 97 degrees (rather than continuously adding steam in this process, give intervals of adding and removing)
6	Invention Principle 22 Bad to Good	Make frequent cracking an advantage -> Insert beneficial materials through cracking (include useful materials in steam or utilize cracking after steaming to add beneficial materials)
7	Invention Principle 24 Use Intermediary	Use cloth to reduce contact with steam to prevent cracking and can prevent water drops from the top coming into direct contact
8	Invention Principle 29 Use of Air Medium or Fluids	Because nutrients may be lost due to cracking, when steaming, concentrate ginseng made while steaming and mix concentrate with steam

3. Test Results on TRIZ Solutions (1)

1st Test Results

- Of solutions deduced through contradiction table and brainstorming, select solutions that can be used in current steaming system and conduct tests

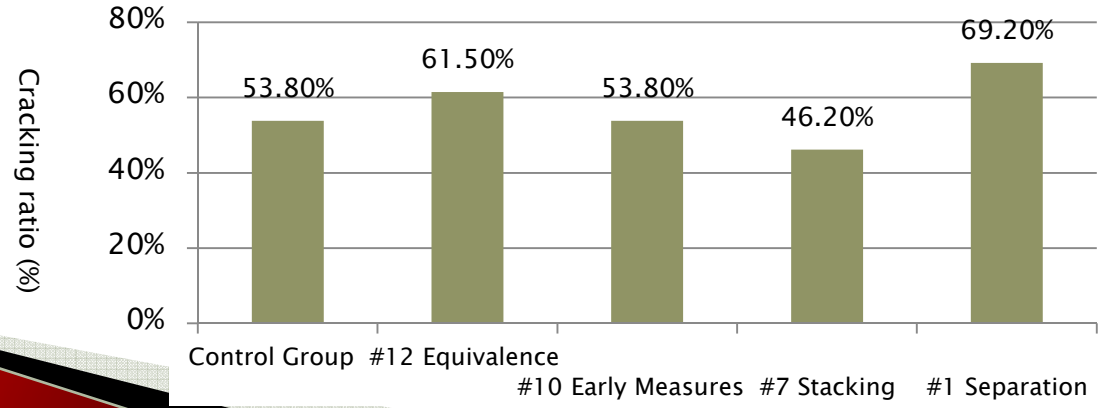
※ Test Condition: 10 min at 40℃ on 13 fresh ginseng ⇨ 2 hours at 97℃

▶ Invention Principle 12 Equivalence: Hang so there is no contact point
Applied solutions: **Hang upper part with string to steam**

▶ Invention Principle 10 Early Measures: Treat starch paste with pre-treatment
Applied solutions: Use flour paste brush and apply evenly on fresh ginseng and then steam after 30 min

▶ Invention Principle 7 Stacking: Make board stand at angle to steam

▶ Invention Principle 1 Separation: Separate and steam
Applied solutions: **1st steaming: 40℃, 10 min ⇨ 90℃, 30 min,**
2nd steaming: 40℃, 10 min ⇨ 97℃, 2 hours



3. Test Results on TRIZ Solutions (2)

2nd Test Results

- Select new solutions or solutions deduced in the past through brainstorming with the research team but were not execute and conduct tests

※ Test Conditions: Pre-heat 13 fresh ginseng ⇨ 90 min at 94℃

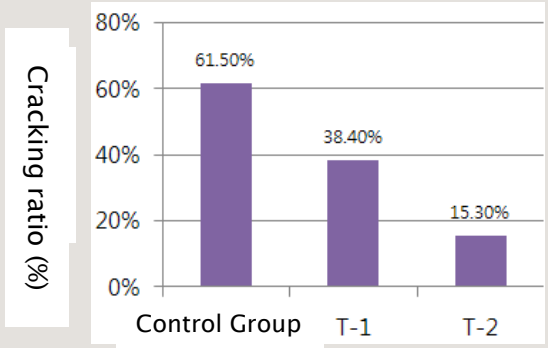
▶ Invention Principle 11 Preceding Measures: As preventive measure, pre-treat **(50-55℃)**

▶ Invention Principle 1 Separation: Separate and steam (gradually raise temperature from pre-heating process)

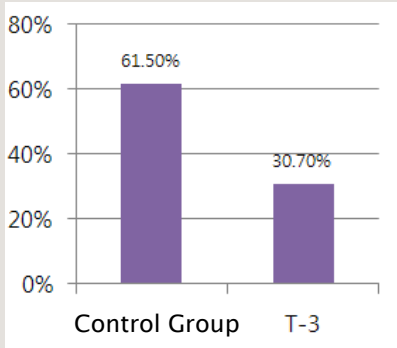
▶ Invention Principle 10 Early Measures: Use rack, etc so that steam does not come into direct contact

▶ Invention Principle 16 Excess or Lacking: Use high-temp heating source to check correlation of qty of steam and cracking

< Invention Principle 11. Preventive Measure Test Results



< Invention Principle 16. Heat Source Test Results >

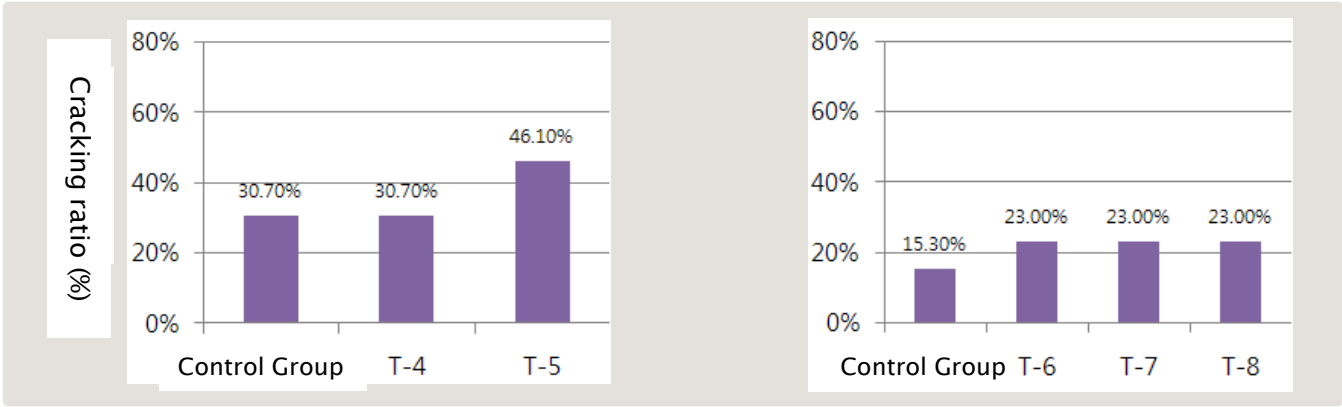


Note. T-1: Dry for 30 min at 50~55℃ warm wind dryer and steam for 90 min at 95℃
T-2 : Dry for 1 hour at 50~55℃ warm wind dryer and steam for 90 min at 95℃
T-3 : Use heat source & steam for pre-heat and when steaming, 90 min at 95℃

3. Test Results on TRIZ Solutions (2)

2nd Test Result

< Invention Principle 1. Separation Test Result >



< Invention Principle 10. Early Measures Test Result >

Note. T-4: Pre-heat (87℃, 80 min→Cooling→87℃, 40 min), when steaming, use heat source at 95℃, 90 min
T-5: Pre-heat (50℃, 20 min→ 87℃, 50 min), when steaming, use heat source at 95℃, 90 min
T-6: 50℃ warm-air dryer 1 hour, 95℃, 90 min, when steaming, cover using container
T-7: 50℃ warm-air dryer 1 hour, 95℃, 90 min, when steaming, locate on upper-most steaming rack
T-8: 50℃ warm-air dryer 1 hour, 95℃, 90 min, when steaming, place 2 above steaming rack

⇒ Of 4 solutions applied in 2nd test, prove that **preventive measures through warm-air dryer are effective solutions**

⇒ Also when using heat source or steaming aside from medium that increases temperature, covering the top so that moisture does not come into direct contact can also prevent cracking, so find **optimal conditions through recreation and combination of effective methods**

3. Test Results on TRIZ Solutions (3)

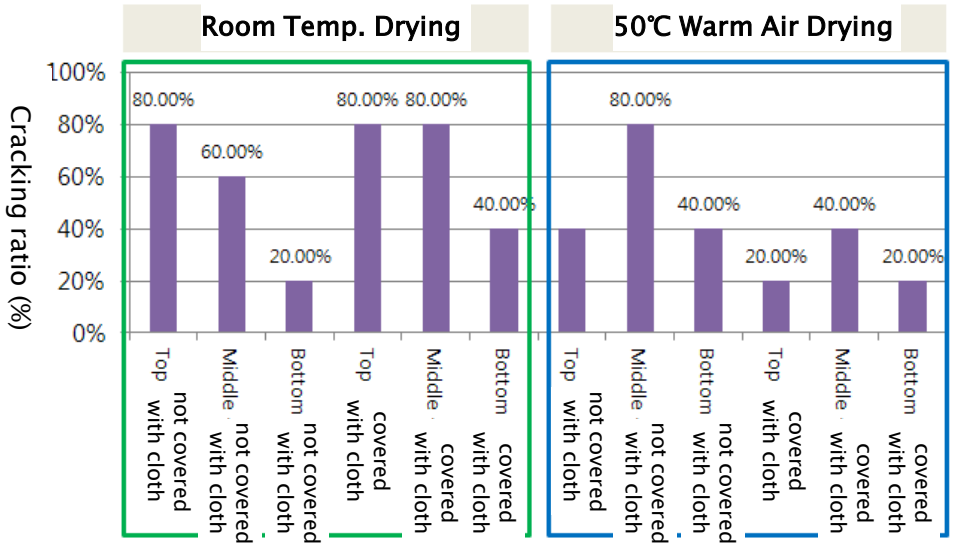
3rd Test Results

- Reproduce methods deduced as effective methods in 2nd test results and perform optimization tests

※ Test Conditions: 5 ginseng each, pre-heat (40℃→80℃) ⇨ 97℃, 60 min steaming. However, for 3rd tests, test on stored (defrosted for long period at room temp)

▶ Invention Principle 11 Preceding Measures:
Pre-treat as prevent measures (50~55℃)

▶ Invention Principle 10 Early Measures:
Use racks so that steam does not comine into direct contact



- 3rd test results for examining the effects of direct contact of position and steam in steamer on cracking apparently showed that there was no correlation for position in steamer, but was analyzed to have relatively less cracking

- Areas covered with cloth to prevent direct contact of steam can show better effect for pre-treatment with warm-air drying

The above results who that through pre-treatment with warm-air drying applying preceding and early measures, and by covering top with cloth, cracking problem that occurs in red ginseng processing can be resolved

4. Summary and Conclusion (1)

- **This research examines whether the creative problem-solving technique of TRIZ can be applied to R&D in the bio sector to present a breakthrough that can resolve current problems**

- Recruit cooperative research team to select target for red ginseng processing technology standardization and search for solutions focusing on the 'cracking problem' that occurs in the red ginseng processing procedure

- First, define the problem that is to be resolved, categorize the problem and cause of problem, and then deduce contradictions that occur in red ginseng processing procedures. Conduct analysis in a way to resolve technical contradictions among the contradictions that have been deduced

- Deduce IFR by applying the 40 invention principles. At this time, use contradiction matrix and perform brainstorming with research team and examine preceding literature to deduce invention principles that can be applied and come up with practical ideas that can be used in red ginseng processing procedures

- Consider economic feasibility and realistic possibility of deduced IFR to select solutions and execute them

▶ After the 1st test conducted by applying the principles of equivalence, early measures, stacking, and separation, there were cracking similar to the control group, and was judged not to be IFR

▶ After the 2nd test conducted by applying the principles of preceding measures, separation, early measures, and excess and lacking, there were reduced cracking in test conditions that utilized the principles of preceding measures, excess and lacking, and early measures

▶ After steaming according to 2nd test results, the methods deduced through useful measures were reproduced and 3rd tests for optimization were conducted

- In result it is judged that the cracking problem that occurs in red ginseng processing can be resolved through pre-treatment using warm-air drying or by covering the top with a cloth by applying the preceding and early measure principles

4. Summary and Conclusion (2)

- **When examining the results of this study, it is judged that by integrating TRIZ in the bio sector, it can resolve not only the said problems, but also contribute in innovative R&D and technological development through creative thinking and by thinking outside of the box**

- Using TRIZ, look for solutions that can resolve the cracking problem that occurs during red ginseng processing without requiring additional investment facilities or expenses
- In the future, will analyze changes in contents of active ingredients such as saponin resulting from prevention of cracking to check the effects of solution and will monitor results according to scale-up
- Based on the various TRIZ techniques, it is expected to examine problems from new perspectives other than customary ones to find solutions
- However, because TRIZ was introduced to Korea only about 10 years ago, it is only used in a few large conglomerates, applied in limited industrial sectors and are slow to be distributed and utilized in the academic sector, so TRIZ has not yet been established as an innovative method
- Thus, efforts to develop TRIZ theories suitable to the Korean environment and to strengthen education programs and find various success cases are necessary

4. Summary and Conclusion (3)

- **TRIZ should be assertively introduced to gain a head start in core technologies and industrial platform technologies in the bio sector that is being recognized as key technologies to resolving pan-world problems such as aging populations and climate changes**

- **However, use of TRIZ in the bio sector is still limited**

  ⇒ In order to use Su-field analysis and modern TRIZ tools (i.e. Goldfire Innovator, etc), the relationship between constituents (harmful effects, beneficial effects, etc) must be defined, but most bio research do not have clearly distinguished relationships among constituents

- **Use of TRIZ in the limited bio sector is expected to result in more successful R&D by examining problems from TRIZ train of thought, and multi-faceted approaches to resolve contradictions (cause of problem)**

- **Once effect mechanisms and interaction of bio phenomena are defined, it is expected that it will be applied in a broader range in the bio sector**

"Resource is limited but Creativity is unlimited."

– Front door of POSCO –

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