USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY20 Annual Performance Progress Report
Due date: August 31, 2021

Cover Page

Principle Investigator (PI):	Jiajia Rao
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Fiscal Year:	2020
USDA-ARS Agreement ID:	59-0206-0-130
USDA-ARS Agreement Title:	Essential Oil Nanoemulsion to Control of Mycotoxin Production in Cereals
FY20 USDA-ARS Award Amount:	$ 58,749
Recipient Organization:	North Dakota State University Office of Grant & Contract Accouting NDSU Dept 3130, PO Box 6050 Fargo, ND 58108-0650
DUNS Number:	80-388-2299
EIN:	45-6002439
Recipient Identifying Number or Account Number:	FAR0031915
Project/Grant Reporting Period:	6/1/20 - 5/31/21
Reporting Period End Date:	5/31/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
FST-R	Essential Oil Nanoemulsion to Control of Mycotoxin Production in Cereals	$ 58,749
	FY20 Total ARS Award Amount	**$ 58,749**

Jiajia Rao

08/18/2021

Principal Investigator Date

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* MGMT – FHB Management
FST – Food Safety & Toxicology
    R- Research
    S – Service (DON Testing Labs)
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
EC-HQ – Executive Committee-Headquarters
BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
    SPR – Spring Wheat Region
    NWW – Northern Soft Winter Wheat Region
    SWW – Southern Soft Red Winter Wheat Region

Project 1: *Essential Oil Nanoemulsion to Control of Mycotoxin Production in Cereals*

1. **What are the major goals and objectives of the research project?**

   Objective one: Preparation, Characterization of essential oil nanoemulsions their major chemical compounds nanoemulsions;
   Objective two: Antifungal and antimycotoxigenic mechanisms of action (MOA) of essential oil nanoemulsions;
   Objective three: Application of essential oil nanoemulsions for reducing fusarium infection and DON production during the micro malting process

2. **What was accomplished under these goals or objectives?** *(For each major goal/objective, address these three items below.)*

   a) **What were the major activities?**
      Major activities in objective one:
      - The chemical composition of two different type of clove oils and three different type of hop essential oils were measured
      - The impact of clove oil type including clove leaf oil and clove bud oil on the physicochemical properties on clove oil-in-water nanoemulsions was investigated
      - The physiochemical stability of hop oil-in-water nanoemulsion was evaluated.

      Major activities in objective two:
      - Antifungal and antimycotoxigenic mechanisms of action (MOA) of abovemetioned two clove oil-in-water nanoemulsions and one hop oil-in-water nanoemulsion have been explored.

   b) **What were the significant results?**
      Significant results in objective one
      - The chemical composition of clove bud oil and clove leaf oil showed noticeable differences. For instance, a higher percentage of eugenol and eugenol acetate appeared in clove bud oil, whereas no eugenol acetate was found in clove leaf oil.
      - By blending 25 wt% of clove oil with 75 wt% of corn oil in oil phase (5 wt%), clove bud oil (CBO)-in-water nanoemulsion and clove leaf oil (CLO)-in-water nanoemulsion showed highly physical stable with the mean particle size < 170 nm.
      - The concentration of major chemical constituents such as eugenol and caryophyllene in nanoemulsion maintained constant during storage time (over one week) at room temperature.

- There are total over 15 compounds have been measured in hop essential oil, which accounts for 87.48% in total.
- The major chemical composition of hop essential oil is beta-myrcene, humulene followed by caryophyllene, nerol and 3,3,6-trimethyl-1,5-heptadiene.
- The physical stabled 5 wt% of hop oi- in-water nanoemulsion can be fabricated by blending 30% of medium-chain triglyceride (MCT) with 70% of hop oil.

Significant results in objective two

- The antifungal activities of nanoemulsions against two Fusarium graminearum isolates were strongly dependent on the clove oil concentration. For instance, clove leaf oil nanoemulsion displayed an appreciable higher antifungal activity compared to clove bud oil nanoemulsion at a lower clove oil concentration.
- The morphological changes of fungal hyphae and spores revealed that both nanoemulsions could effectively inhibit fungal mycelial growth and spore germination, but in a different antifungal mode of actions.
- Hop essential oil has weaker antifungal and inhibition of mycotoxin production compared to clove oil
- Hop essential oil can have altered total lipid content and fatty acid profile in spore cell membrane, thus inhibit the spore germination and mycotoxin production.

c) List key outcomes or other achievements.

One manuscript has been submitted to the journal and under the review processing.

- Haiyang Jiang, Shaobin Zhong, Paul Schwarz, Bingcan Chen, Jiajia Rao. Chemical composition of essential oils from leaf and bud of clove and their impact on the antifungal and mycotoxin inhibitory activities of clove oil-in-water nanoemulsions. Submitted.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns and/or restrictions, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

Yes. Due to the COVID-19 pandemic, majority of labs have not been functional, some of labs has very restricted rule in terms of student capacity for conducting experiment for half years. In addition, one hired PhD planning to come to my lab 2020 fall from China. Due to the impact of COVID, she could not physically be here. Therefore, a new PhD student has been hired and physically come to my lab in 2021 fall.

4. What opportunities for training and professional development has the project provided?

- The project provided training opportunities for two Ph. D students.

- One Ph. D student obtained the second place of research oral competition in Toxicology & Safety Evaluation division at the 2021 annual Institute of Food Technologists (IFT) meeting.

5. How have the results been disseminated to communities of interest?

Yes. Results have been presented in the following conferences (* denotes the corresponding author)

1) Haiyang Jiang, **Jiajia Rao***. Chemical composition, antifungal and mycotoxin inhibitory activities of essential oil nanoemulsions from leaves and buds of clove. 2021 Institute of Food Technologists (IFT) Annual Meeting, July 18–21, Virtual.

2) Haiyang Jiang, **Jiajia Rao***. Clove Oil-in-Water Nanoemulsion Mitigates Growth of Fusarium graminearum and Trichothecene Mycotoxin Production during the Malting of Fusarium Infected Barley. 2020 National Fusarium Head Blight Forum. December, 2020, poster presentation, Virtual.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (6/1/20 - 5/31/21). The term “support” below includes any level of benefit to the student, ranging from full stipend plus tuition to the situation where the student’s stipend was paid from other funds, but who learned how to rate scab in a misted nursery paid for by the USWBSI, and anything in between.

1. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY19 award period?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY19 award period?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

3. **Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

4. **Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

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Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with full or partial support through the USWBSI during the FY20 award period (6/1/20 - 5/31/21). All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations.

NOTE: Leave blank if you have nothing to report or if your grant did NOT include any VDHR-related projects.

Name of Germplasm/Cultivar	**Grain Class**	**FHB Resistance**	**FHB Rating** (0-9)	**Year Released**
N/A	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
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Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

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Publications, Conference Papers, and Presentations

Instructions: Refer to the PR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY20 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (6/1/20 - 5/31/21**) should be included. If you did not publish/submit or present anything, state 'Nothing to Report' directly above the Journal publications section.

NOTE: Directly below each citation, you **must** indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in the publication/ presentation. See example below for a poster presentation with an abstract:

> Z.J. Winn, R. Acharya, J. Lyerly, G. Brown-Guedira, C. Cowger, C. Griffey, J. Fitzgerald, R.E. Mason and J.P. Murphy. 2020. "Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat." In: S. Canty, A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum (*p. 12.), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

N/A

Books or other non-periodical, one-time publications.

N/A

Other publications, conference papers and presentations.

Haiyang Jiang, **Jiajia Rao***. Chemical composition, antifungal and mycotoxin inhibitory activities of essential oil nanoemulsions from leaves and buds of clove. 2021 Institute of Food Technologists (IFT) Annual Meeting, July 18–21 (Poster).
Status: Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Haiyang Jiang, **Jiajia Rao***. Clove Oil-in-Water Nanoemulsion Mitigates Growth of Fusarium graminearum and Trichothecene Mycotoxin Production during the Malting of Fusarium Infected Barley. 2020 National Fusarium Head Blight Forum. December, 2020, poster presentation, Virtual.
Status: Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)