

LWL
TR-74-43
c. 2

TECHNICAL REPORT NO. 74-43

IMPROVED PACKAGING OF WATER PURIFICATION TABLET

by

Joseph L. Carney
Environment and Survival Branch

April 1974

Final Report

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LWL
1R-74-43

IN REPLY REFER TO

STSNL-YPB

15 October 1974

SUBJECT: Improved Packaging of Iodine Water Purification
Tablet, LWL Technical Report No. 74-43

TO: Distribution List of LWL Technical Report No. 74-43

1. U.S. Army Land Warfare Laboratory Technical Report No. 74-43,
subject as above, was recently distributed to your Command or
Organization.

2. Since this Laboratory has the responsibility for Specification
MIL-W-283 (Water Purification Tablet, Iodine) and any research
related to this item, the inclosed comments are forwarded for
your information and completeness of records.

S. David Bailey
Acting Director
Food Sciences Laboratory

MRR
AMK

Inc.
As Stated

cc:

L. Spano

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15 October 1974

MEMORANDUM FOR RECORD

SUBJECT: Improved Packaging for Iodine Water Purification Tablet

1. Reference is made to LWL Task No. 05-S-69, Final Technical Report 74-43, Subject: Improved Packaging of Water Purification Tablet, by J.L. Carney, April 1974.
2. This report referenced in paragraph one above is a culmination of efforts by LWL to show that the Aclar blister package is equal to the glass bottle as a packaging material for the iodine water purification tablet. However, for the sake of completeness, certain additional information not contained in this report should be emphasized.
 - a. The tablets used in the Aclar package were carefully selected and culled by the contractor prior to packaging. Similarly, tablets in the Aclar packages were selectively chosen before and after environmental storage test exposure so that only the best tablets were used in the titration and solubility tests. This was done intentionally in order to avoid any tablet deterioration that may have been caused because of inadequate heat seals in the Aclar package. In contrast, no preferred selection of tablets prior to bottling or after the environmental testing was allowed for the bottle. The bottle had to stand the test as it came from the normal procurement production line, and would therefore contain some inferior tablets. Thus, for the purposes of these tests, the Aclar package was given a preferred advantage at time zero as to the quality of tablet that was packaged. Even with this advantage, the Aclar package did not provide any significant difference in iodine tablet potency over the bottled tablets.
 - b. Cost estimates for the mass production of Aclar package were conservatively estimated at \$0.18 per package (24 tablets) by the contractor in 1970 of which \$0.06 would represent the cost of the iodine tablet. The 1970 cost per bottle of 50 tablets from Van Brode Milling Co. was \$0.12 and included labor, shipping costs, etc.

STSNL-YPB

MEMORANDUM FOR RECORD

15 October 1974

With the necessity of having to scale the equipment up from a pilot production to a commercial production, many costly problems could be anticipated. In addition to the recent sharp rise in the cost and scarcity of plastic polymers, and dependence on a single material (Aclar) the estimated cost/unit would make the delivery price prohibitive. The final cost of the package would be 2-3 times the cost of the material (tablets) being protected, a position difficult to defend.

Morris R. Rogers

Morris R. Rogers
Research Microbiologist
Biotechnology Group
Pollution Abatement Division
Food Sciences Laboratory

AMK *MCC*

AD-784047

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The new method of packaging the iodine tablets consists of sealing the individual tablets in a blister sheet and packaging two blister sheets in an overwrapper packet. The blister sheet measures 1 3/4" x 2 1/8" and contains 12 transparent blister units surrounded by a steel gray color match for comparison with the color of the iodine tablets. The new simplified directions for use are printed on the back of each blister sheet and on the exterior surface of the overwrapper packet.		

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INTRODUCTION

For many years iodine tablets which are used by the military for water purification have been packaged in glass bottles of 50 tablets. This method of packaging has serious deficiencies since the iodine tablet is unstable when exposed to air and is ultrasensitive to moisture. Deterioration sets in as soon as a bottle is opened and corrosion of the metal cap which often takes place during storage means that in many cases the tablets have already deteriorated prior to the initial opening of a bottle. The tablets must be used according to directions and the paper label containing the directions is easily removed or destroyed. Furthermore the present packaging does not provide any means to identify the color change from steel gray to white or brown which is the visible indication of deterioration.

The need for an improved method of packaging iodine water purification tablets has been recognized for many years. In 1963 a study report by Radiation Technology, Inc., discussed many of the problems relating to the manufacture and supply of the tablets (Ref. 1). The urgency of the requirement was highlighted during the combat in Vietnam as discussed in two reports in 1967 (Refs. 2 & 3). The report by the Army Concept Team in Vietnam (ACTIV) (Ref. 3) noted that of 78 soldiers interviewed, only 40 soldiers knew that the color of an undeteriorated purification tablet should be gray. The interviews established that many soldiers could be using ineffective tablets, unaware that the water they were drinking had not, in fact, been purified. A 1968 study report conducted by the Naval Medical Field Research Laboratory, Camp Lejeune, NC (Ref 4), recommended that iodine tablets be packaged in a manner which would provide long time protection of the tablet, means for easily dispensing the tablet and improved means of inspecting tablets in storage.

DISCUSSION

Recognizing the problem, the US Army Natick Laboratories (NLABS) Natick, MA initiated development to find a better method of packaging the iodine water purification tablets. The task included screening seven types of thin film packaging methods to determine the best material with which to package individual tablets. The iodine water purification tablet (FSN 6850-985-7166) contains the following ingredients: 19.3 - 21.3 mg. tetraglycine hydroperiodide, 82.5 - 92.3 mg. anhydrous sodium acid phosphate and 6.0 mg. talc. The tetraglycine hydroperiodide is very unstable when exposed to air, rapidly passing from the solid state to iodine vapor which is highly corrosive. In addition, the iodine compound is ultrasensitive to moisture and very rapidly deteriorates in the presence of even a very small amount of moisture. These characteristics made it very difficult to find a suitable packaging material. From the survey, only one material, Aclar, a fluorohalocarbon film manufactured by the Allied Chemical Company, Morristown, NJ was found to be acceptable. The other six materials were either attacked by free iodine or permeable to iodine and water vapor.¹

The NLABS study was conducted to investigate various versions of strip packaging and blister packaging but none was considered acceptable enough to warrant manufacturing of a field quantity. In this study no attempt was made to provide a steel gray color match.

Following this material study, and as a result of funding and program priority problems which prevented further work by NLABS, the US Army Land Warfare Laboratory (LWL) initiated a task to continue the effort to improve the tablet packaging.

Initial Evaluation Quantity Contract

A contract, DAAD05-70-C-0089, was awarded to the Columbia Research Corporation, Gaithersburg, MD in October 1969 for development and production of a quantity of improved packaging of the water purification tablets.

Based on the NLABS information three commercially available Aclar films, 22A, 22C and 33C, in varying thicknesses were considered as candidate materials for the new packaging. Laminates of Aclar/polyethylene/polyvinylchloride and of Aclar/polyethylene/aluminum foil were also included in the initial screening for the best tablet packaging material. The blister sheet type of packaging was determined the most appropriate and a twelve tablet per blister sheet quantity was established. The final blister sheet assembly was constructed of two sheets of 22A Aclar of 5 mil thickness and was 2-1/8" x 1-3/4" in size. The tablets were sealed between the Aclar sheets by a grid work heat seal method. A 2 mil thick, pressure sensitive adhesive backed, steel grey acetate label applied to the back of the blister sheet provides the desired color match background for the tablets.

¹Personal communication, Sep 68 with Dr. Kwak H. Hu, Natick Laboratories Project Officer for the study. There was no published report of the study.

The assembly is shown at the top of Figure 1. Tear point cut-outs were provided to facilitate the tearing open of the Aclar sheets to remove each tablet.

Although Aclar is an excellent iodine vapor barrier, it does not provide the individually sealed iodine tablets adequate protection against water vapor intrusion during long term storage. It was decided to overwrap two blister sheets with a heat sealed laminate film of 0.5 mil Mylar/0.35 mil aluminum foil/ 3 mil C79 polyolefin; a product of Continental Can Corporation, Baltimore, MD (Ref. 5). In addition to providing the needed protection against water vapor intrusion the overwrap provides protection against damage to the blister sheets. The directions for use of the tablet and manufacturing data were presented on the overwrap. See lower right side of Figure 1 for the overwrap with two blister sheets partially removed. For comparison the standard wax sealed bottle of 50 iodine tablets is shown on the left side of the figure.

The iodine water purification tablets used in this development program were manufactured by Van Brodie Milling Co., Inc., Clinton, MA in accordance with Military Specification MIL-W-283F, Water Purification Tablet, Iodine.

Environment Testing of Initial Evaluation Quantity

NLABS conducted rough handling and accelerated laboratory environmental storage tests of the new package. Additional environmental testing was scheduled to be conducted at Edgewood Arsenal, Edgewood, MD but was cancelled because of a breakdown in the environmental chambers. The rough handling tests were conducted in accordance with the following schedule:

- PHASE I:
 - a. Condition case at 72°F, 50% R.H., for 24 hours.
 - b. Drop test from 21 inches using 1 cycle of ASTM Standard 775, Note 4.
 - c. Vibrate case at 268 rpm, 1G, for 1 1/2 hours.
- PHASE II:
 - a. Condition case at -20°F for 24 hours
 - b. Drop test from 21 inches using 1 cycle of ASTM Standard 775, Note 4.
 - c. Vibrate case at 268 rpm, 1G, for 1 1/2 hours

Table I outlines the sampling periods, storage conditions and the number of samples agreed upon for the study. Of the 240 samples withdrawn for evaluation, 80 were retained for package evaluation, while 160 were tested for solubility and titratable iodine test using the procedures described in Military Specification MIL-W-283F. The standard bottle of 50 tablets was subjected to the same storage study for comparison.

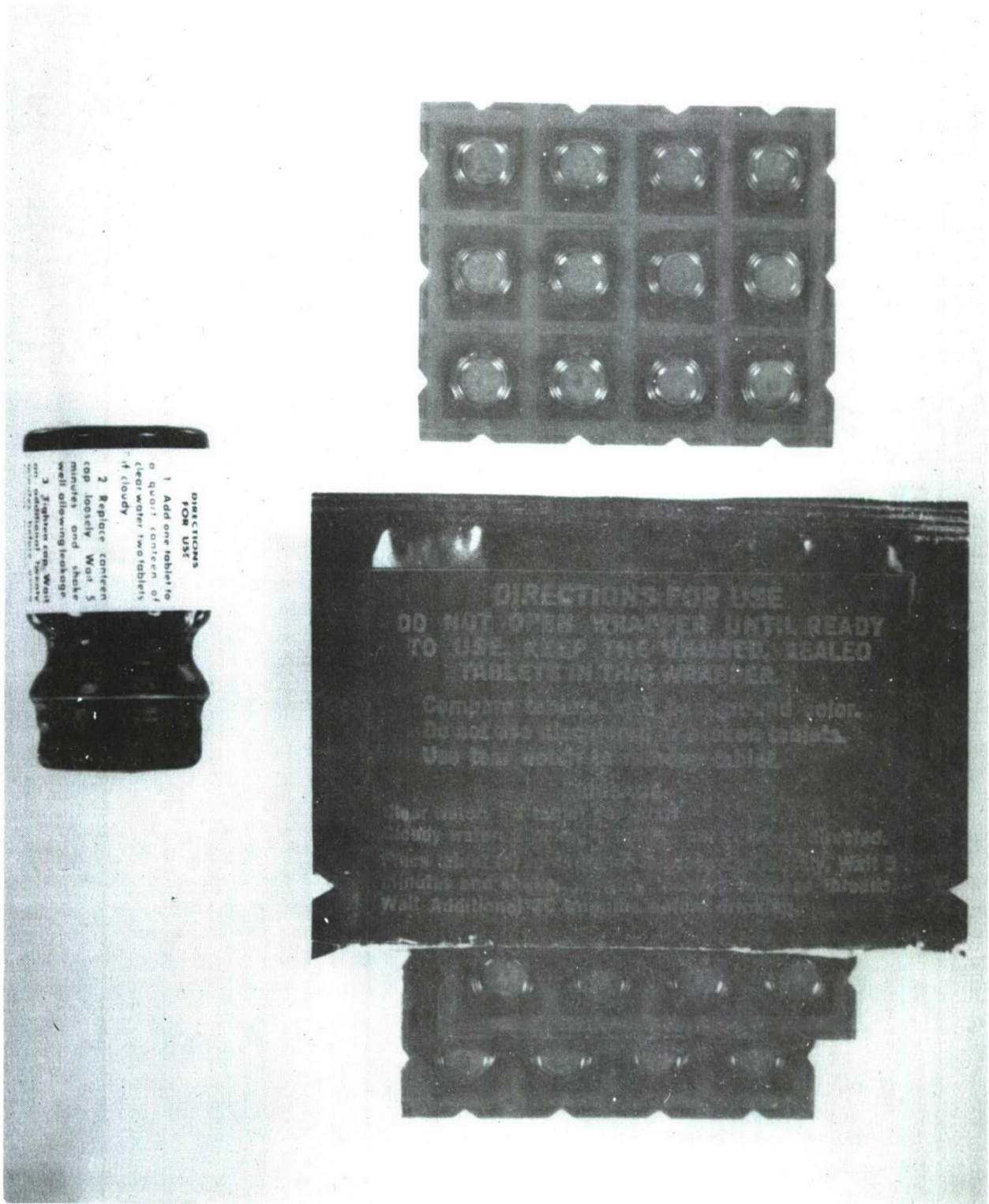


Figure 1. Standard Bottle and New Package

TABLE I. IODINE TABLET STORAGE STUDY

Storage Conditions	<u>30 days</u>		<u>60 days</u>		<u>90 days</u>		<u>120 days</u>	
	A	B	A	B	A	B	A	B
Initial (240 for A & B)								
140°F 10% r.h. (static)	240	240	240	240	240	240	240	240
(rough handle)	240		240		240		240	
100°F 95% r.h. (static)	240	240	240	240	240	240	240	240
(rough handle)	240		240		240		240	
72°F 50% r.h. (static)	240	240	240	240	240	240	240	240
(rough handle)	240		240		240		240	
-65°F (static)	240	240	240	240	240	240	240	240
(rough handle)	240		240		240		240	

A - Overwrapped Packet (two blister sheets/packet)

B - No Protective Overwrap (two blister sheets/unit)

The storage study was terminated by NLABS after the packets were exposed for three months to the various environmental storage conditions because the solubility and the iodine content of the water purification tablets were adversely affected by exposure to high temperature and/or relative humidity (see Reference 6).

Because the data presented in Reference 6 seemed contradictory in many instances, the raw data of the storage study was subjected to a thorough statistical analysis. Although some of the data was statistically unexplainable, it was concluded that the unfavorable results of the storage tests were caused by two principal factors, namely unsatisfactory iodine tablets prior to packaging and lack of controlled packaging conditions which resulted in moisture being trapped in the cellulose acetate color match film affixed to the back of each blister sheet.

Second Evaluation Quantity Contract

Based on the failure analysis of the first quantity of packaged tablets produced and tested, a fixed price contract with proper changes was awarded to Columbia Research Corporation in August 1971 (Reference 7). This contract, DAAD05-72-C-0028, required changes in the pressure and dwell time of the heat sealing cycle, a wider heat seal in the grid, sealing tray improvements and stringent moisture control of components and the assembly atmosphere. In addition a careful selection and culling of the available tablets was made

in an attempt to prevent random tablet failure confusing the subsequent test data.

Environmental Testing of Second Evaluation Quantity

The packets of iodine tablets produced in the second evaluation quantity contract were subjected to accelerated laboratory environmental tests in a similar manner as were the packets of the initial evaluation quantity. Data over a six month storage test period was tabulated (see Reference 8). Analysis of the raw data of this storage study by USALWL Research Analysis Office showed that there was no significant difference in the iodine tablet potency whether stored in bottles or blister sheets in overwrapped packets.

Field Evaluation

On 19 July 1973 a meeting was held between representatives of Office of The Surgeon General, NLABS and LWL and it was agreed that the environmental storage test results showed that there was no significant difference between the standard bottle packaging system and the LWL blister sheet in overwrapped packet packaging system. It was also agreed that LWL should proceed with field evaluations.

A partial analysis of 139 questionnaires completed by one class of Ranger Students is enclosed as Appendix A. A review of 57 responses from the Special Forces Group at Fort Devens, MA, is enclosed as Appendix B. A letter of comments representing the general consensus of 15 of the 20 Special Forces personnel at Fort Gulick, Canal Zone, is enclosed as Appendix C.

CONCLUSIONS

1. There is no significant difference in iodine tablet potency whether stored in bottles or blister sheets in overwrapped packets. Based upon tablet discoloration, the evaluation results were almost identical. One-third of the reports noted discoloration in each case.

2. Evaluation under field conditions showed that the bottle was preferred over the packets. The troops stated that it was more difficult to extract tablets from the blister sheet and that the tablets were easily crushed or broken.

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5. Brown, Denny F. and Derick, Charles T., "A Blister Sheet and Pouch Overwrapper Package for the Iodine Water Purification Tablet," Final Report, Contract No. DAAD03-70-C-0089, AD #733921, Columbia Research Corp., Gaithersburg, MD 20760, October 1961.
6. US Army Natick Laboratories, AMXRE-PRIM Laboratory Report 70-F-8, Subject: Titratable Iodine and Solubility Analyses of the Iodine Water Purification Tablet (MIL-W-283) Packaged in an Experimental Aclar 22A Blister Sheet and Pouch Overwrapper as furnished by USALWL Under Contract No. DAAD03-70-C-0089 with Columbia Research Corporation, Gaithersburg, Maryland, 4 March 1971.
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8. US Army Natick Laboratories, AMXRE-PRIM Final Laboratory Report 72-F-11, Subject: Titratable Iodine and Solubility Analysis of an Improved Aclar Blister Packed Iodine Water Purification Tablet 2 March 1973, (USALWL Task No. 05-S-69).

DEPARTMENT OF THE ARMY
RANGER DEPARTMENT
75TH INFANTRY (RANGER)
UNITED STATES ARMY INFANTRY SCHOOL
Fort Benning, Georgia 31905

MAJ Spies/jp/5-6768

ATSH-R-0

31 January 1974

SUBJECT: Packaging of Iodine Water Purification Tablet

MjH
THRU: ~~Assistant Commandant
United States Army Infantry School
ATTN: ATSH-CD-TE
Fort Benning, GA 31905~~

TO: Commander
US Army Land Warfare Laboratory
ATTN: AMXLW-DES/Mr. Carney
Aberdeen Proving Ground, MD 21005

1. Per informal agreement of Ranger Department, USAIS, with Mr. Carney, your office, the durability test of the blister package for iodine tablets is completed.
2. Only one class of Ranger students participated in this test. A questionnaire from each student who graduated (136) is being forwarded along with quantities of used bottles and blister sheets to your office under separate cover.
3. Ranger students, when cold and wet, experienced difficulty opening the blister sheet. They generally preferred the bottle over the blister sheet. It was suggested that the current bottle top be painted grey (to match a usable tablet) instead of black.

FOR THE DIRECTOR:

Frank H. Scott

FRANK H. SCOTT
LTC, Infantry
Deputy Director

APPENDIX A

PARTIAL ANALYSIS OF 139 RANGER QUESTIONNAIRES
FROM FORT BENNING, GA

25 February 1974

MEMORANDUM FOR RECORD

SUBJECT: Review of Questionnaires Received from Ranger Evaluation of Iodine Tablet Blister Pack

1. As requested by Mr. J. Carney, Project Officer on LWL Task No. 05-S-69, the data from 139 Ranger-completed questionnaires have been examined and a partial analysis of the data has been accomplished.
2. It is quite apparent from the questionnaire data that the blister pack with overwrap is much more difficult to handle (while extracting tablets) than the bottle. The handling problem is undoubtedly the major factor in the 71% overall preference for the bottle over the blister pack. It should be recognized, however, that this field evaluation was probably conducted in an environment where iodine tablets were not always required (There was one comment to that effect.). Other questions were also raised as to the validity of this evaluation, but this does not mean that the overall results should be discounted; rather, it does mean that any additional evaluation underway should be continued and any decision to continue or discontinue the LWL task should be based upon additional evaluations, together with the Ranger evaluation.
3. One of the important findings is that there are two "mechanical" problems with the LWL blister package. There were 22 final comments that tablets within the blister packs were crushed or broken. This condition occurred as a result of both opening the blister pack (due to hand pressure) and storage on the person. For example, it was noted that tablets in blister packs should not be carried in back pockets because they would be crushed when one sat down. Hence, it appears that the bottle provides superior physical protection for the tablets over the blister pack both during tablet extraction and transport.
4. One third of the questionnaires which gave tablet condition information noted one or more discolored tablets from the LWL packages. The equivalent information on the bottle is not as reliable because the question was difficult to interpret on this point, but the percentage of questionnaires noting discolored tablets from the bottles was almost identical, i.e., 32%. However, there were eight different questionnaires (6% of total) in which it was reported that whole bottles of tablets went bad.
5. It appears that the only unanswered question which bears on the disposition of this task (05-S-69) is: "Are bottles a significantly inferior storage container compared with the LWL package in operational usage?" That is, is the health protection factor down when tablets from a previously opened bottle are used? This question can be partially answered in terms of tablet appearance--and


AMXLW-RAO

25 February 1974

SUBJECT: Review of Questionnaires Received from Ranger Evaluation of Iodine
Tablet Blister Pack

could be partially resolved in favor of the bottle--with a color match indicator for the bottle as discussed previously by Natick personnel and as noted by comments in the questionnaires from the Ranger exercise. In fact, the safety aspects of the bottle might be completely resolved by increasing the basic load of bottles and directing the individual soldier to open a new bottle whenever there is reason to doubt the quality of tablets in a previously opened bottle. However, the economics and logistics of such a direction could possibly rule unfairly in favor of the blister package.

6. In summary, the results of the Ranger field evaluation tend to negate, by new findings, the operational superiority of the LWL blister package over the bottle for iodine tablet storage which had been previously acceded to by Natick personnel.


ELLSWORTH B. SHANK
Research Analysis Office

CF:

CO/TD

C, MOD

A/C, DED

C, E&S

~~Mr.~~ Carney

APPENDIX B

REVIEW OF 57 RESPONSES FROM THE SPECIAL FORCES GROUP
AT FORT DEVENS, MA

DEPARTMENT OF THE ARMY
Company A, 3rd Battalion
10th Special Forces Group (Airborne), 1st Special Forces
Fort Devens, Massachusetts 01433

SFBB-AC

25 February 1974

SUBJECT: Summary Report of Water Purification Blister Sheet Packets

CDR, U.S. Army Land Warfare Laboratory
ATTN: AMXLW-DES/ Mr. J.L. Carney
Aberdeen Proving Ground MD 21005

1. Section I and II of the Command and User Questionnaire were completed on the same day for control.
2. No unopened bottles or blister sheet packets were retained.
3. Consensus of opinion was in favor of the bottled water purification packets over the blister sheet packets. (39 for bottle, 18 for packets)
4. The bottle system is definitely easier to use in cold weather and can be used wearing gloves. The bottle is easier to keep with the canteen by taping to the cap strap of the canteen or in the pouch included on the later model canteen covers. The blister sheet packet has the two advantages of a color comparison capability and individual compartmentalization. The color comparison capability could be applied to the bottle by coloring the inside of the cap for comparison. The individual compartmentalization advantage would seem to be marginal considering the disadvantages of bulkier and more fragile packing for the blister sheet.

Charles W. Karwan

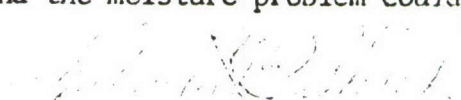
CHARLES W. KARWAN
CPT, Infantry
S3 Officer

8 March 1974

MEMORANDUM FOR RECORD

SUBJECT: Review of Second Set of Operational Test Results on Iodine Tablet Packaging

1. Reference: RAO MFR, AMXLW-RAO, 25 Feb 74, subject: Review of Questionnaires Received from Ranger Evaluation of Iodine Tablet Blister Pack.
2. A second set of completed questionnaires was received on the operational evaluation of the packaging of the iodine tablet (E&S Task 05-S-69). This set of responses came from the Special Forces Group at Fort Devens, MA. Although there were some basic differences between the results of the two tests, two of the key indicators were nearly identical; viz., the preference to carry blister packs was 36% in the SF test compared with 37% in the first evaluation by the Rangers (referred MFR), and the overall preference for the blister pack was 31% for the SF test compared with 29% for the Ranger evaluation.
3. The cross-section of personnel on the SF test was completely different from the Ranger evaluation, where the personnel evaluating the packaging were all recent West Point graduates. In the Fort Devens evaluation, the personnel were primarily enlisted men (46) with service ranging from one year to 22 years. The 11 officers involved had varied lengths of service and their ranks ranged from 2d LT to MAJ.
4. The basic comments in this evaluation were much the same as in the previous evaluation, i.e., the men had more difficulty in opening the blister pack than in opening the bottle. They found that tablets were crushed and packages were cracked while carrying the blister packs, and tablets were crushed in the act of opening the blister packs. Again, there were comments on the difficulty of opening the packages in cold weather and at night.
5. The basic difference between the results of the two evaluations was the number of reported cases of bad tablets in the blister package; there were only six reported cases of bad tablets (11%) compared with 33% in the first evaluation. The reported cases of bad tablets in the bottle was down slightly from 33% to 30%. However, there were no reported cases of entire bottles of tablets going bad.
6. Although this second evaluation makes the proper disposition of the packaging task (05-S-69) much clearer, i.e., it tends to lend further support to task termination, it will be interesting to find out what happens in the evaluation in Panama where the cold factor is not present and the moisture problem could be greater.


ELLSWORTH B. SHANK
Research Analysis Office

CF:
CO/TD
C, MOD
A/C, DED
C, E&S
Mr. Carney

APPENDIX C

COMMENTS ON 20 QUESTIONNAIRES FROM SPECIAL FORCES PERSONNEL
AT FORT GULICK, CANAL ZONE



DEPARTMENT OF THE ARMY
HEADQUARTERS, SECURITY ASSISTANCE FORCE FOR LATIN AMERICA
3D SPECIAL FORCES BATTALION, 7TH SPECIAL FORCES GROUP (AIRBORNE), 1ST SPECIAL FORCES
FORT GULICK, CANAL ZONE

SCARSF-SD

27 March 1974

SUBJECT: Water Purification Tablet Test

Commander
U.S. Army Land Warfare Laboratory
ATTN: AMXLW-DES/Mr J.C. Carney
Aberdeen Proving Grounds, Maryland 21005

1. Subject test was completed by members of Co A, 3/7th SF Gp (Abn), 1st SF, Fort Gulick, Canal Zone during the period 4 Feb 74 thru 14 Mar 74. Notation should be made of the time in service of the majority of tested personnel (8 to 18 years). Unused tablets accompany this letter.
2. Most notable observations were made by CPT Kimball and SFC Taylor. Comments on the tablets as listed below represent the general consensus of fifteen (15) of the twenty (20) personnel tested, whom preferred the bottle.
 - a. Packet was too difficult to open.
 - b. Tablets in packet were often crushed.
 - c. Packet was too easily lost.
 - d. Packet was hard to attach to canteen cover where it serves as a reminder of use.
 - e. Packet dissolves when exposed to Army Insect Repellent.
 - f. Packet is impossible to open if one is wearing gloves or a bandage.
3. Three individuals favored the packet because it was not bulky and could be conveniently placed out of the way.
4. Two personnel had nothing of value to contribute to the testing phase.

FOR THE COMMANDER:

A handwritten signature in cursive script, reading "Jimmy L. Braddock".

JIMMY L. BRADDOCK
Major, Infantry
Adjutant

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